

CONTRIBUTING U.S. GEOLOGICAL SURVEY STAFF

TECHNICAL SUPPORT

Carl S. Carlson, Hydrologist

Michael R. Carpenter, Hydrologist

Art Clark and Central Region drill crew

Devin L. Galloway, Hydrologist

Kenneth W. Hudnut, Geophysicist

Nancy E. King, Geophysicist

A. Scott Lewis, Hydrologic Technician

Steven P. Phillips, Hydrologist

Donald R. Pool, Hydrologist

Diane L. Rewis, Hydrologist

Francis S. Riley, Hydrologist

Michelle Sneed, Hydrologist

EDITORIAL, GRAPHICS, AND TEXT PREPARATION TEAM

Myrna DeBortoli, Technical Editor

Mary Gibson, Editorial Assistant

David Uyematsu, Scientific Illustrator

Report Documentation Page			Form Approved OMB No. 0704-0188					
<p>Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.</p>								
1. REPORT DATE 2002	2. REPORT TYPE N/A	3. DATES COVERED -						
4. TITLE AND SUBTITLE Vertical-Deformation, Water-Level, Microgravity, Geodetic, Water-Chemistry, and Flow-Rate Data Collected During Injection, Storage, and Recovery Tests at Lancaster, Antelope Valley, California, September 1995 Through September 1998			5a. CONTRACT NUMBER					
			5b. GRANT NUMBER					
			5c. PROGRAM ELEMENT NUMBER					
6. AUTHOR(S)			5d. PROJECT NUMBER					
			5e. TASK NUMBER					
			5f. WORK UNIT NUMBER					
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) U.S. Department of the Interior 1849 C. Street, NW Washington, DC 20240			8. PERFORMING ORGANIZATION REPORT NUMBER					
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)			10. SPONSOR/MONITOR'S ACRONYM(S)					
			11. SPONSOR/MONITOR'S REPORT NUMBER(S)					
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release, distribution unlimited								
13. SUPPLEMENTARY NOTES								
14. ABSTRACT								
15. SUBJECT TERMS								
16. SECURITY CLASSIFICATION OF: <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 33.33%; padding: 2px;">a. REPORT unclassified</td> <td style="width: 33.33%; padding: 2px;">b. ABSTRACT unclassified</td> <td style="width: 33.33%; padding: 2px;">c. THIS PAGE unclassified</td> </tr> </table>			a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified	17. LIMITATION OF ABSTRACT SAR	18. NUMBER OF PAGES 149	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified						

Vertical-Deformation, Water-Level, Microgravity, Geodetic, Water-Chemistry, and Flow-Rate Data Collected During Injection, Storage, and Recovery Tests at Lancaster, Antelope Valley, California, September 1995 through September 1998

By Loren F. Metzger⁽¹⁾, Marti E. Ikehara⁽²⁾, and James F. Howle⁽³⁾

U.S. GEOLOGICAL SURVEY

Open-File Report 01-414

Prepared in cooperation with the

**LOS ANGELES COUNTY DEPARTMENT OF PUBLIC WORKS and
ANTELOPE VALLEY-EAST KERN WATER AGENCY**

¹U.S. Geological Survey, Placer Hall, 6000 J Street, Sacramento, CA 95819-6129

²U.S. Department of Commerce, National Oceanic and Atmospheric Administration,
1727 30th Street, Sacramento, CA 95816

³U.S. Geological Survey, P.O. Box 1360, Carnelian Bay, CA 96140

Sacramento, California
2002

**U.S. DEPARTMENT OF THE INTERIOR
GALE A. NORTON, Secretary**

**U.S. GEOLOGICAL SURVEY
Charles G. Groat, Director**

The use of firm, trade, and brand names in this report is for identification purposes only and does not constitute endorsement by the U.S. Geological Survey.

For additional information write to:

District Chief
U.S. Geological Survey
Placer Hall, Suite 2012
6000 J Street
Sacramento, CA 95819-6129

Copies of this report can be purchased from:
U.S. Geological Survey
Information Services
Box 25286
Federal Center
Denver, CO 80225

CONTENTS

Abstract.....	1
Introduction	1
Description of Study Area	2
Acknowledgments	2
Injection Site and Test Design	5
Vertical Deformation Monitoring	8
Dual-Extensometer Construction	8
Dual-Extensometer Instrumentation.....	8
Data Collection and Processing.....	12
Ground-Water-Level Monitoring.....	12
Construction of Nested Piezometers.....	12
Continuous Water-Level Measurements	18
Instrumentation	18
Data Collection and Processing.....	23
Periodic Water-Level Measurements	27
Microgravity Surveys	51
Gravity Station Construction	51
Gravity Data Collection.....	51
Geodetic Monitoring.....	58
Differential-Leveling Network	58
Bench-Mark Installation	58
Differential-Leveling Surveys.....	60
Data Processing	61
Continuous GPS Surveying	61
GPS Station Construction and Instrumentation.....	63
Data Collection and Processing.....	63
Tiltmeter Network.....	67
Installation	67
Data Collection and Processing.....	67
Water-Chemistry Monitoring.....	73
Sample Collection Methods.....	74
Analytical Methods.....	78
Flow-Rate Monitoring	78
Data Collection	78
Data Processing	78
Summary.....	81
References Cited.....	81
Appendix A. Discussion on Preparing for a Microgravity Survey	82
Appendix B. Discussion on Making a Microgravity Measurement	83
Appendix C. Discussion on Sources of Microgravity Survey Errors	84

FIGURES

1. Map showing generalized surficial geology and location of study area and of ground-water basin and subbasins in the Antelope Valley, California.....	3
2. Generalized geologic section showing relation of lacustrine clay deposits to younger and older alluvium and aquifers in the Lancaster and North Muroc subbasins in the Antelope Valley ground-water basin, California.....	4
3. Map showing locations of the injection site, the extensometer site, and the area of the injection, storage, and recovery study at Lancaster, Antelope Valley, California	6
4. Time line of activities associated with cycles 1–3 of the injection, storage, and recovery study and with monitoring at Lancaster, Antelope Valley, California, September 1995 through September 1998	7
5. Schematic showing below-ground installation of the dual extensometer at the Avenue K-8 and 5th Street West well field in Lancaster, Antelope Valley, California	9
6. Schematic showing above-ground installation of the dual extensometer at the Avenue K-8 and 5th Street West well field in Lancaster, Antelope Valley, California	10
7. Time-series plots of vertical deformation of the aquifer system measured at the shallow and deep extensometers in Lancaster, Antelope Valley, California, April 1996 through September 1998	11
8. Map showing locations of ground-water-level monitoring sites used for the injection, storage, and recovery study at Lancaster, Antelope Valley, California	13
9–12. Diagrams showing:	
9. Geophysical logs, well-construction diagram, and lithologic log of the borehole for nested piezometers 7N/12W-27F5–8 at the extensometer site in Lancaster, Antelope Valley, California.	16
10. Geophysical logs of the borehole for nested piezometers 7N/12W-27P5–8 at the injection site in Lancaster, Antelope Valley, California.	19
11. Well construction of nested piezometers 7N/12W-27F5–8 at the extensometer site in Lancaster, Antelope Valley, California.	20
12. Well construction of nested piezometers 7N/12W-27P5–8 at the injection site in Lancaster, Antelope Valley, California.	21
13. Photographs showing typical pressure transducer and data-logger system used for recording continuous ground-water levels.....	22
14–18. Time-series plots showing:	
14. Local barometric pressure at the extensometer site in Lancaster, Antelope Valley, California, April 1996 through September 1998	23
15. Ground-water levels recorded in piezometers 7N/12W-27F5–8 at the extensometer site in Lancaster, Antelope Valley, California, April 1996 through September 1998.....	24
16. Ground-water levels recorded in piezometers 7N/12W-27H5 and 27H7 at the Avenue K-8 and Division Street well field in Lancaster, Antelope Valley, California, April 1996 through May 1997	26
17. Ground-water levels recorded in abandoned production well 7N/12W-27J5 at the Avenue K-8 and Division Street well field in Lancaster, Antelope Valley, California, April 1996 through May 1997	27
18. Ground-water levels recorded in piezometers 7N/12W-27P5, 27P6, and 27P8 at the injection site in Lancaster, Antelope Valley, California, April 1998 through September 1998.....	28
19. Hydrographs showing periodic water levels in wells and piezometers for the injection, storage, and recovery study at Lancaster, Antelope Valley, California, March 1996 through September 1998	47
20. Map showing locations of gravity stations used for the injection, storage, and recovery study at Lancaster, Antelope Valley, California.....	52
21. Diagram showing gravity station construction	53

22. Diagram showing top view of a LaCoste and Romberg Model D gravity meter and schematic wiring diagram of an electronic data logger and barometer.....	54
23. Map showing locations of vertical-control bench marks used in differential-leveling surveys for the injection, storage, and recovery study at Lancaster, Antelope Valley, California	59
24. Photograph showing typical vertical-control bench mark used for differential-leveling surveys.....	60
25. Map showing locations of regional geodetic control points used to determine horizontal and vertical coordinates for bench marks in the differential-leveling network for the injection, storage, and recovery study at Lancaster, Antelope Valley, California	62
26–29. Graphs showing:	
26. Change in land-surface altitude of bench marks and gravity stations measured during surveys on March 26–27, April 15–16, and April 29, 1996, relative to land-surface altitudes measured on September 25–28, 1995, in Lancaster, Antelope Valley, California	64
27. Change in land-surface altitude of bench marks and gravity stations measured during surveys on November 12–15, 1996 relative to land-surface altitudes measured on November 4, 1996, in Lancaster, Antelope Valley, California	65
28. Change in land-surface altitude of bench marks and gravity stations measured during surveys on November 4, 1996; November 14, 1996; April 9, 1997; and February 17, 1998, relative to land-surface altitudes measured on September 25–28, 1995, in Lancaster, Antelope Valley, California	66
29. Change in land-surface altitude of bench marks along the extensometer line of the differential-leveling network measured during surveys on April 15–16, 1996; November 4, 1996; November 15, 1996; April 9, 1997; and February 17, 1998, relative to land-surface altitudes measured on March 26–27, 1996, in Lancaster, Antelope Valley, California	67
30. Photographs showing permanent Global Positioning System station at the injection site in Lancaster, Antelope Valley, California.....	68
31. Photograph showing temporary Global Positioning System base station at the Antelope Valley–East Kern Water Agency district office in Antelope Valley, California	69
32. Graphs showing change in land-surface altitude at the injection site derived from continuous Global Positioning System daily solutions for the injection phases of cycles 1, 2, and 3 at Lancaster, Antelope Valley, California.....	70
33. Graphs showing change in land-surface altitude at the injection site derived from continuous Global Positioning System subdaily solutions for the injection phases of cycles 1 and 2 at Lancaster, Antelope Valley, California.....	71
34. Map showing locations of tiltmeters used to monitor the magnitude and direction of ground tilting associated with direct well injection during cycle 2 at Lancaster, Antelope Valley, California	72
35. Photograph showing typical tiltmeter installation for recording the magnitude and direction of ground tilting associated with direct well injection at Lancaster, Antelope Valley, California	73
36. Graph showing magnitude and direction of tilt recorded during the injection phase of cycle 2 by tiltmeters 1N, 2N, and 3N in Lancaster, Antelope Valley, California	73
37. Map showing locations of water-chemistry monitoring sites for cycles 1 and 2 of the injection, storage, and recovery study at Lancaster, Antelope Valley, California.....	75
38. Photograph showing flowmeter used to measure injection and extraction flow rates at injection well 7N/12W-27P3 in Lancaster, Antelope Valley, California.....	79
39. Time-series plots showing injection and extraction flow rates at injection wells 7N/12W-27P2 and 27P3 in Lancaster, Antelope Valley, California, April 1996 through September 1998	80

TABLES

1. Well-construction data for wells used in the injection, storage, and recovery study at Lancaster, Antelope Valley, California, September 1995 through September 1998	14
2. Water levels in piezometers and wells measured for the injection, storage, and recovery study at Lancaster, Antelope Valley, California, September 1995 through September 1998	30
3. Microgravity data collected during cycle 2 of the injection, storage, and recovery study at Lancaster, Antelope Valley, California, November 1996 through April 1997	55
4. Microgravity data collected during cycle 3 of the injection, storage, and recovery study at Lancaster, Antelope Valley, California, February 1998 and June 1998	57
5. Summary of materials used to construct bench marks for the injection, storage, and recovery study at Lancaster, Antelope Valley, California, September 1995 through September 1998	60
6. Summary of Global Positioning System surveying sessions used to determine coordinates for bench marks in the differential-leveling network for the injection, storage, and recovery study at Lancaster, Antelope Valley, California, October 23 and 24, 1995	61
7. Survey periods of differential-leveling surveys for the injection, storage, and recovery study at Lancaster, Antelope Valley, California, September 1995 through February 1998.....	63
8. Survey periods of continuous Global Positioning System surveys, data recording intervals, and number and duration of daily data sessions for the injection, storage, and recovery study at Lancaster, Antelope Valley, California, March 1996 through September 1998	69
9. Physical properties and major-ion concentrations in water samples collected during cycles 1 and 2 of the injection, storage, and recovery study at Lancaster, Antelope Valley, California, March 1995 through January 1998	86
10. Trace metal and metalloid concentrations in water samples collected during cycles 1 and 2 of the injection, storage, and recovery study at Lancaster, Antelope Valley, California, March 1995 through June 1997	120
11. Trihalomethane concentrations, trihalomethane formation potentials, and associated parameters for water samples collected during cycles 1 and 2 of the injection, storage, and recovery study at Lancaster, Antelope Valley, California, April 1995 through January 1998.....	126
12. Minimum reporting levels for physical properties and major ions, trace metals and metalloids, and trihalomethanes and associated parameters by agency and summary of analytical methods used to analyze water samples collected during cycles 1 and 2 of the injection, storage, and recovery study at Lancaster, Antelope Valley, California, April 1995 through January 1998.....	76

CONVERSION FACTORS, VERTICAL DATUM, WATER-CHEMISTRY UNITS, ABBREVIATIONS AND ACRONYMS, AND WELL-NUMBERING SYSTEM

Conversion Factors

Multiply	By	To obtain
Length		
inch (in.)	2.54	centimeter
inch (in.)	25.4	millimeter
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
Area		
square foot (ft ²)	929.0	square centimeter
square foot (ft ²)	0.09290	square meter
square mile (mi ²)	259.0	hectare
square mile (mi ²)	2.590	square kilometer
Volume		
acre-foot (acre-ft)	1,233	cubic meter
acre-foot (acre-ft)	0.001233	cubic hectometer
cubic foot (ft ³)	0.02832	cubic meter
Flow Rate		
gallon per minute (gal/min)	0.06309	liter per second
Mass		
pound, avoirdupois (lb)	0.4536	kilogram
Pressure		
pound per square inch (lb/in ²)	6.895	kilopascal

Temperature in degrees Celsius ($^{\circ}\text{C}$) can be converted to degrees Fahrenheit ($^{\circ}\text{F}$) by the following equation:

$$^{\circ}\text{F} = (1.8 \ ^{\circ}\text{C}) + 32.$$

Changes in land-surface altitudes from differential-leveling surveys were measured in metric units and shown in this report as metric units so that comparisons can be made with GPS data shown in this report. Coordinates determined by Global Positioning System (GPS) surveying generally are reported in metric units. The industry standard for GPS usage is that field measurements are done in the metric system.

Vertical Datum

Sea level: In this report “sea level” refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)—a geodetic datum derived from a general adjustment of the first-order level nets of the United States and Canada, formerly called Sea Level Datum of 1929.

Abbreviated Water-Chemistry Units

Chemical concentration is given either in milligrams per liter (mg/L) or micrograms per liter ($\mu\text{g}/\text{L}$). Micrograms per liter is equivalent to “parts per billion.” Specific conductance is given in microsiemens per centimeter at 25 degrees Celsius ($\mu\text{S}/\text{cm}$ at $^{\circ}\text{C}$).

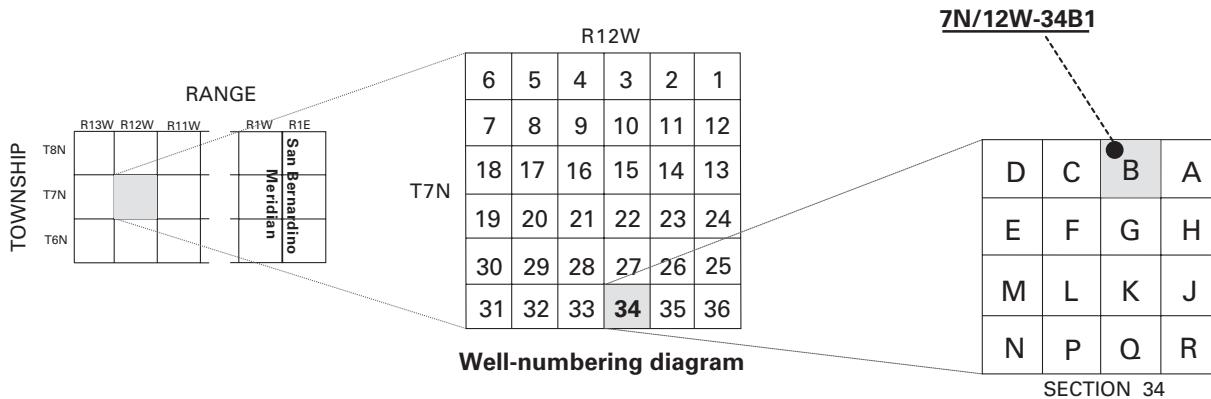
Abbreviations and Acronyms

cm	centimeter
mGal	milliGal
μGal	microGal
μm	micrometer
V	volt

AC	alternate current
AHr	ampere-hour
AVEK	Antelope Valley–East Kern Water Agency
Caltrans	California Department of Transportation
CSBM	Los Angeles County Surveyor Bench Mark
GPS	Global Positioning System
LAC	Los Angeles County Department of Agricultural Commissioner and Weights and Measures
LACDPW	Los Angeles County Department of Public Works
LINJ	Lancaster INjection well
NAD27	North American Datum of 1927
NAD83	North American Datum of 1983
NEIC	National Earthquake Information Center
NGVD29	National Geodetic Vertical Datum of 1929
NTU	nephelometric turbidity unit
NWIS	National Water Information System
PVC	polyvinyl chloride
SCEC	Southern California Earthquake Center
SCIGN	Southern California Integrated GPS Network
SWP	State Water Project
THM	trihalomethane
TON	threshold odor number
USGS	U.S. Geological Survey

Well-Numbering System

Wells are identified and numbered according to their location in the rectangular system for the subdivision of public lands. Identification consists of the township number, north or south; the range number, east or west; and the section number. Each section is divided into sixteen 40-acre tracts lettered consecutively (except I and O), beginning with "A" in the northeast corner of the section and progressing in a sinusoidal manner to "R" in the southeast corner. Within the 40-acre tract, wells are sequentially numbered in the order they are inventoried. The final letter refers to the base line and meridian. In California, there are three base lines and meridians; Humbolt (H), Mount Diablo (M), and San Bernardino (S). All wells in the study area are referred to the San Bernardino base line and meridian (S). Well numbers consist of 15 characters and follow the format 007N012W34B001S. In this report, well numbers are abbreviated and written 7N/12W-34B1. The following diagram shows how the number for well 7N/12W-34B1 is derived.



Vertical-Deformation, Water-Level, Microgravity, Geodetic, Water-Chemistry, and Flow-Rate Data Collected During Injection, Storage, and Recovery Tests at Lancaster, Antelope Valley, California, September 1995 through September 1998

By Loren F. Metzger, Marti E. Ikehara, and James F. Howle

ABSTRACT

A series of freshwater injection, storage, and recovery tests were conducted from September 1995 through September 1998 to evaluate the feasibility of artificially recharging ground water in the Lancaster area of the Antelope Valley, California. The tests used two production wells at a well field located in the southern part of the city of Lancaster. Monitoring networks were established at or in the vicinity of the test site to measure vertical deformation of the aquifer system, water-level fluctuations, land-surface deformation, water chemistry, and injection well flow rates during water injection and recovery. Data presented in this report were collected from a dual extensometer; 10 piezometers; 1 barometer; 27 active or abandoned production wells; 31 gravity stations; 124 bench marks; 1 permanent and 1 temporary continuous Global Positioning System (GPS) station; 3 tiltmeters; and 2 electromagnetic flowmeters from September 1995 through September 1998. This report discusses the location and design of the monitoring networks and the methods used to collect and process the data, and presents the data in tables and graphs.

INTRODUCTION

Historically, ground-water withdrawals in the Lancaster area of the Antelope Valley in southern California have exceeded natural replenishment, resulting in overdraft and land subsidence. Since the 1920's, ground-water levels have declined as much as

200 feet (ft) in the area and land subsidence has exceeded 6 ft in some areas (Ikehara and Phillips, 1994). Reliance on ground water eased somewhat in the 1970's due to the importation of surface water from northern California by way of the State Water Project (SWP) and the California Aqueduct. However, rapid population growth and the resulting demand for water has increased ground-water withdrawals and renewed concerns about overdraft and subsidence.

To address these concerns, the U.S. Geological Survey (USGS), in cooperation with the Los Angeles County Department of Public Works (LACDPW) and the Antelope Valley–East Kern Water Agency (AVEK), conducted a series of freshwater injection, storage, and recovery tests in the Lancaster area of the Antelope Valley, California, from September 1995 through September 1998 as part of a study to evaluate the feasibility of artificially recharging the ground-water system in the Lancaster area. The objectives of the study were to (1) develop a better understanding of the aquifer system, (2) assess the effects of injection, storage, and recovery on the aquifer system, and (3) develop tools to help plan and manage a larger injection program.

The USGS role in this study was to collect and analyze hydraulic and aquifer-system deformation data, develop a simulation/optimization model for use in designing and managing a larger-scale injection program, and determine the factors controlling the formation and fate of trihalomethanes (disinfection by-products) in the aquifer system. This report describes the methods of data collection and presents the data collected during the injection, storage, and recovery tests from September 1995 through September 1998. Subsequent reports will describe the use of microgravity surveys to determine water-level changes (Jim Howle, U.S. Geological Survey, written commun., 2000), the determination of the formation and fate of

trihalomethanes (Miranda Fram, U.S. Geological Survey, written commun., 2000; Roger Fujii, U.S. Geological Survey, written commun., 2000); and the development of a simulation/optimization model (Steve Phillips, U.S. Geological Survey, written commun., 2000).

As part of the injection, storage, and recovery tests, monitoring networks were established to measure vertical deformation of the aquifer system, ground-water levels, changes in microgravity, land-surface deformation, injection and extraction water chemistry, and injection and extraction flow rates. Compaction and expansion were measured at a dual extensometer site; barometric pressure was also measured at the site. Water levels were monitored at 13 active and abandoned production wells and 10 nested piezometers. Microgravity was measured at 31 stations. Geodetic data was collected at 124 vertical-control bench marks, 1 permanent and 1 temporary continuous Global Positioning System (GPS) stations, and 3 tiltmeters. Water-chemistry samples were collected from 17 active production wells and the 10 nested piezometers and analyzed. Flow data were collected using meters mounted on two wells used for water injection.

Description of Study Area

The study area encompassed several square miles within and just south of the city of Lancaster, Antelope Valley, California (fig. 1). Lancaster is in the south central part of the valley, in the western part of the Mojave Desert, and is about 50 miles (mi) north of Los Angeles. The Antelope Valley is a triangular-shaped, topographically closed basin covering about 2,200 square miles (mi^2). Annual rainfall at Lancaster averaged about 8.0 inches for 1974–98 (Western Regional Climate Center, accessed July 10, 1999). Amargosa Creek, the most prominent natural surface feature in the study area, trends north and northwest through the study area. Amargosa Creek is ephemeral, and flow generally occurs only after periods of intense rainfall. Land use is a mixture of light industrial, commercial, and residential development interspersed with large tracts of undeveloped land.

Bloyd (1967) divided the valley into 12 ground-water subbasins based on locations of faults, bedrock, and physiographic boundaries. The study area is in the Lancaster subbasin (fig. 1), which is filled with alluvial

and lacustrine deposits, which, in places are as much as 5,000 ft thick (Brenda and others, 1960; Mabey, 1960; Londquist and others, 1993). The alluvial deposits consist of interbedded heterogeneous mixtures of fine-grained silt, coarse-grained sand, and gravel (Dutcher and Worts, 1963; Bloyd, 1967; Durbin, 1978), and the lacustrine deposits primarily consist of thick layers of blue-green silty clay and brown clay; the clay layers are interbedded with sand and silty sand layers (Dibblee, 1967). Stratigraphic, hydrologic, and water-chemistry data were used to divide the water-bearing deposits in the Lancaster subbasin into three aquifers: the upper, middle, and lower (David Leighton, U.S. Geological Survey, written commun., 2000). The upper aquifer extends from the water table to an altitude of about 1,950 ft above sea level, the middle aquifer extends from 1,950 to 1,550 ft above sea level, and the lower aquifer extends from 1,550 ft above sea level to the altitude at which bedrock is encountered (fig. 2). In the study area, ground-water flow in the upper aquifer is unconfined to partly confined at depth. Ground-water flow in the lower aquifer is confined by the lacustrine deposits (Londquist and others, 1993). Sneed and Galloway (2000) reported that most of the compaction in the Lancaster area has been caused by dewatering of the lacustrine deposits and other fine-grained alluvial deposits.

Acknowledgments

Individuals who provided assistance and support for this study include Joe Aja, Dean Efstathiou, Mustafa Arika, Eleni Hailu, Dan Jones, Kenneth Rosander, and Eugene Betts of the Los Angeles County Department of Public Works, and Wallace Spinarski and Russell Fuller of the Antelope Valley–East Kern Water Agency.

Field office personnel of the Los Angeles County Department of Public Works, Waterworks and Sewer and Maintenance Division, Lancaster, constructed a building to house the dual extensometer and shelters for two sets of nested piezometers, and kept the injection cycles running despite the various mechanical challenges that arose throughout the study.

Francis Riley and Devin Galloway of the U.S. Geological Survey designed the dual extensometer, provided guidance during its construction, and assembled the above-ground instrumentation.

Robert Reeder and Darrel Bozarth of the Los Angeles County Department of Public Works, Survey

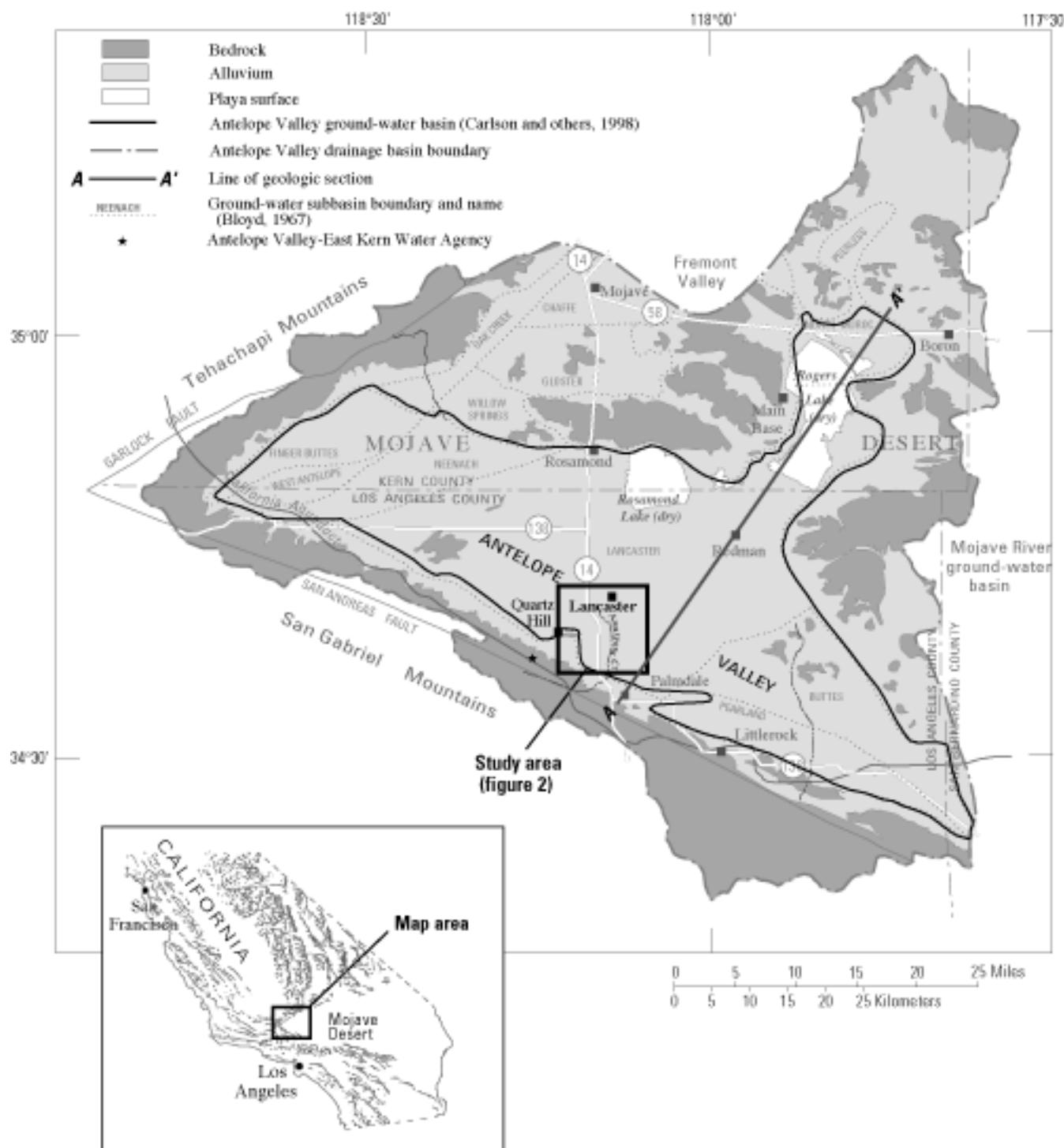
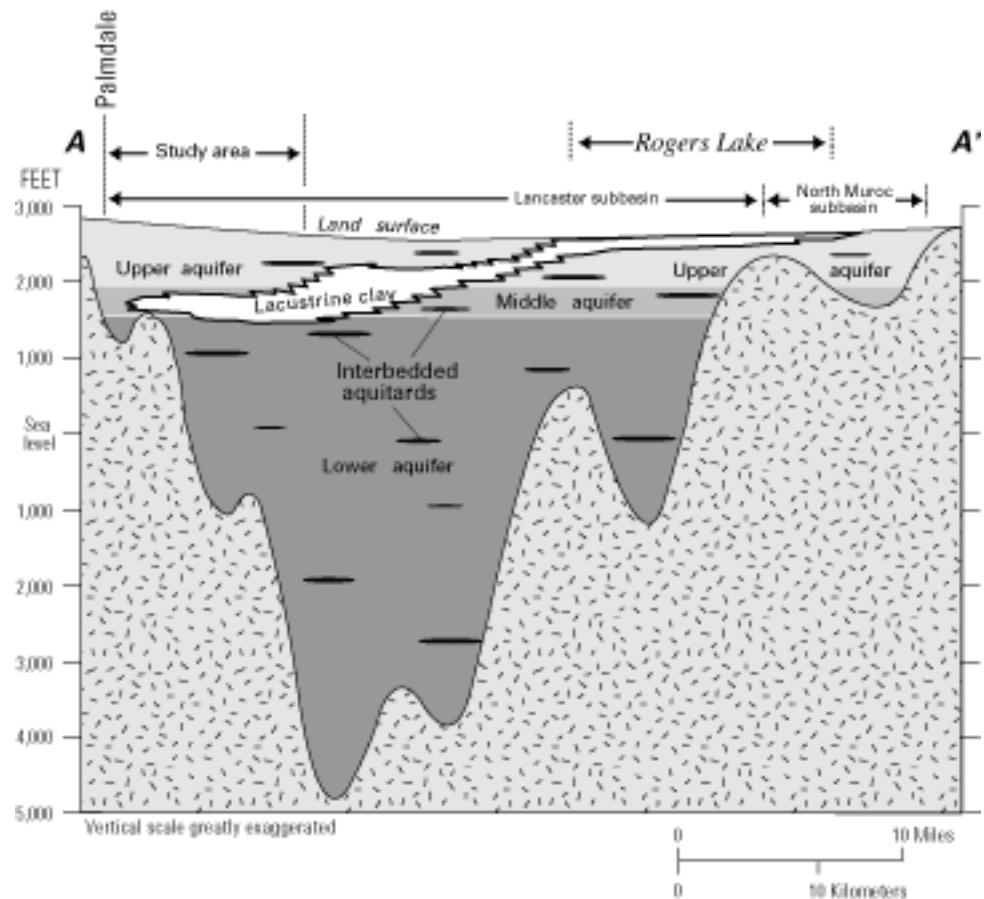


Figure 1. Generalized surficial geology and location of study area and of ground-water basin and subbasins in the Antelope Valley, California. (Modified from Carlson and others, 1998)



EXPLANATION

[Light gray square]	Upper aquifer
[Medium gray square]	Middle aquifer
[Dark gray square]	Lower aquifer
[White square]	Lacustrine clay deposits
[Bedrock symbol]	Bedrock

Figure 2. Generalized geologic section showing relation of lacustrine clay deposits to younger and older alluvium and aquifers in the Lancaster and North Muroc subbasins in the Antelope Valley ground-water basin, California (modified from Londquist and others, 1993). Line of section is shown on figure 1.

Division, assisted in locating buried utilities and in organizing equipment, materials, and manpower for construction of the microgravity and differential-leveling networks. Donald Pool, U.S. Geological Survey, shared expertise in designing and implementing the microgravity surveys. Michael Carpenter, U.S. Geological Survey, provided useful insight regarding the performance characteristics of the particular gravity meter used in this study.

Charles Peer, Gerald Campbell, and the surveying crew of the Los Angeles Department of Public Works, Survey Division, assisted with the establishment and repeated surveying of the differential-leveling network.

Kenneth Hudnut, U.S. Geological Survey, contributed the equipment and expertise for installing and operating a permanent continuous GPS station at the injection site. The GPS station was constructed by Daryl Baisley, Southern California Earthquake Center. GPS data was processed and provided by Jeffrey Behr, Southern California Earthquake Center, and Nancy King, U.S. Geological Survey. Additional GPS equipment was provided by Wayne Vallantine of the California Department of Transportation (Caltrans), Division 7.

Robert Larson of the Los Angeles County Department of Public Works, Materials Engineering Division, installed and operated the tiltmeter network.

Water-chemistry data and information on analytical methods were provided by Maureen Smith, Antelope Valley–East Kern Water Agency; Wilhelmina Solinap, Los Angeles County Department of Agricultural Commissioner and Weights and Measures, Environmental Toxicology Laboratory; and Ramy Gindi, Los Angeles County, Department of Public Works, Sewer and Maintenance Division.

Permission to access privately owned wells to measure water levels was provided by American Auto Sales Incorporated, the U.S. Department of the Air Force and Lockheed-Martin, the El Dorado Mutual Water Company, the West Side Park Mutual Water Company, and the White Fence Farms Water Company.

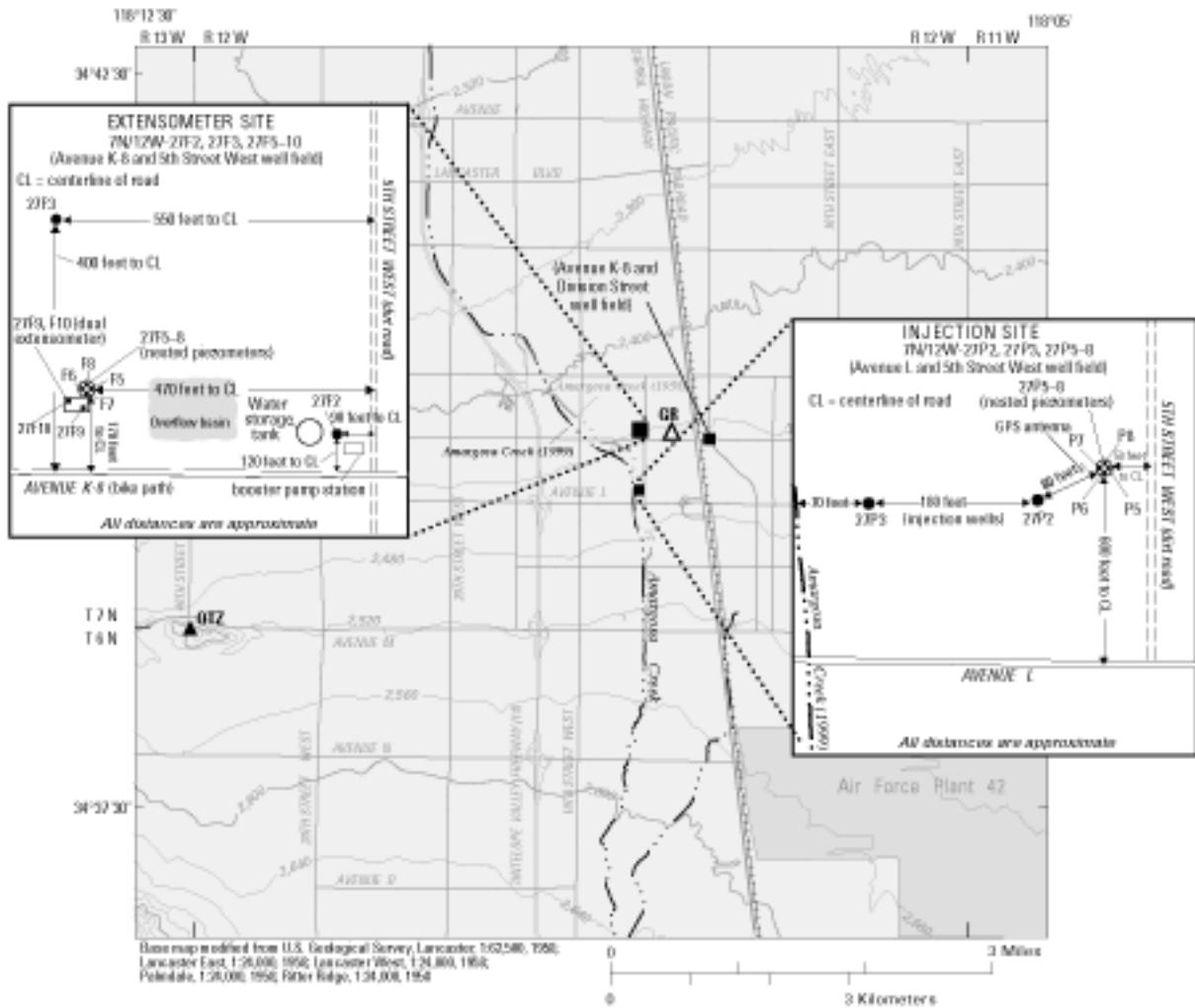
INJECTION SITE AND TEST DESIGN

Two production wells (7N/12W-27P2 and 27P3) in the LACDPW well field (hereinafter referred to as the injection site) at Avenue L and 5th Street West in Lancaster (fig. 3) were used for direct well injection during the injection, storage, and recovery tests. This site was selected because water from the SWP could be conveyed to the well field through an existing water-distribution system connected to AVEK pipelines. This

site also is fairly isolated from engineered structures that could be damaged by changes in land-surface altitude during the tests or that might interfere with data collection. These two wells were selected for injection because each is completed entirely within the upper and middle aquifers. These aquifers have larger transmissivities and storativities than the lower aquifer and therefore are better suited for injection and recovery (Devin Galloway, U.S. Geological Survey, unpublished data, 1995).

Imported surface water from the SWP was used for well injection because it likely will be the source for future injection water, it was available in the quantities required for the tests, and its chemical composition differed from local ground water and thus could be monitored during the tests. SWP water was conveyed to the injection site from the East Branch of the California Aqueduct at AVEK's Quartz Hill Water Treatment Plant through AVEK's south feeder line and a series of secondary LACDPW distribution lines. LACDPW personnel modified the water lines at the injection site by installing valves to reduce line pressure of the injection water from about 80 pounds per square inch (lb/in^2) to less than 30 lb/in^2 and to control the rate of flow to each well. The injected water moved by gravity through the well column, or 4-inch conductor pipe, and into the aquifer through perforations in the well casing.

Three cycles of aquifer injection, storage, and recovery were completed between September 1, 1995, and September 30, 1998 (fig. 4). Each injection phase lasted 1 to 5 months. Water was injected into wells 7N/12W-27P2 and 27P3 during cycle 1 and cycle 2, but only into well 7N/12W-27P2 during cycle 3. A fairly constant injection rate [between 750 and 800 gallons per minute (gal/min)] was maintained during all three cycles. Each injection phase was followed by a 2- to 4-week storage phase that allowed the aquifer system to partially equilibrate. During the storage phase, other LACDPW production wells within 2 mi of the injection site were not operated. After the storage phase, ground water was pumped from the injection wells into LACDPW's water-distribution system, marking the beginning of the recovery (extraction) phase. One or both of the injection wells were continuously pumped for at least 5 months, except for periods of mechanical problems or maintenance work. During the recovery phase, other LACDPW production wells that had been shut down for the injection and storage phases were returned to normal operation. At least 2 weeks prior to the beginning of subsequent cycles, both the injection wells and the surrounding LACDPW production wells were shut down allowing the aquifer system to partially equilibrate.



EXPLANATION

— 2,640 —
Land-surface altitude—Contour interval 40 feet.
Datum is sea level

▲^{OTZ}
Quartz Hill bedrock reference station

△^{GR}
Gravity reference station

Figure 3. Locations of the injection site, the extensometer site, and the area of the injection, storage, and recovery study at Lancaster, Antelope Valley, California. Amargosa Creek (1999) reflects changes in the creek owing to channel realignment.

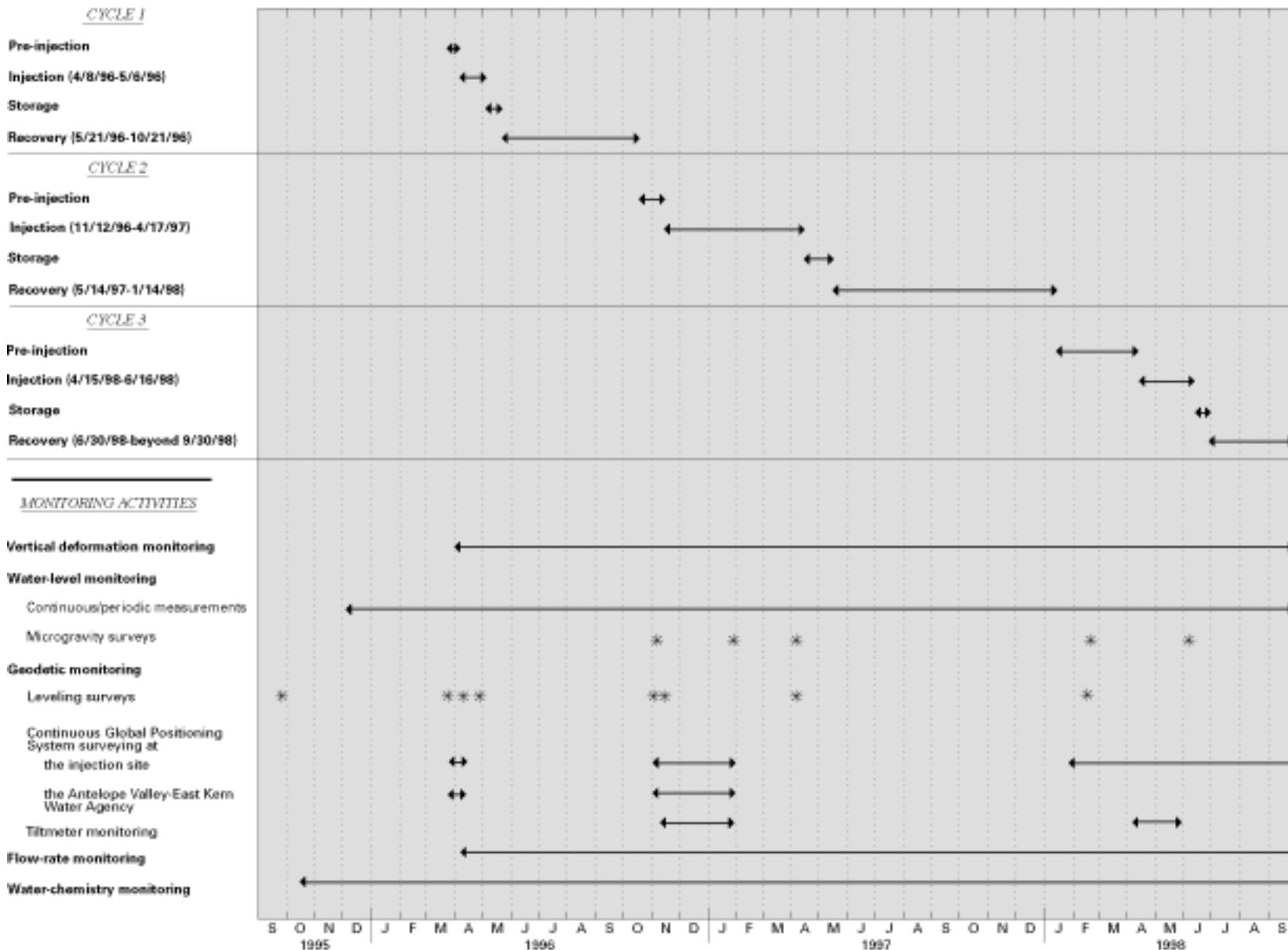


Figure 4. Time line of activities associated with cycles 1–3 of the injection, storage, and recovery study and with monitoring at Lancaster, Antelope Valley, California, September 1995 through September 1998.

VERTICAL DEFORMATION MONITORING

Vertical deformation of the aquifer system (compaction and expansion) was monitored using a dual extensometer (individual shallow and deep extensometers sharing the same instrument table and shelter). An extensometer measures vertical deformation between a specified depth of several feet below land surface and the depth of the extensometer. The dual extensometer was designed to differentiate vertical deformation in the upper and middle aquifers from vertical deformation in the lacustrine unit and lower aquifer. Extensometers generally are not used to measure subsidence; if compressible sediments occur below the depth of the extensometer, measured compaction generally is less than subsidence (Hanson, 1989).

Dual-Extensometer Construction

The dual extensometer was constructed at the LACDPW Avenue K-8 and 5th Street West well field (hereinafter referred to as the extensometer site), about 0.5 mile north of the injection site (fig. 3). The borehole for the shallow extensometer was drilled to 735 ft below land surface, corresponding to the bottom of the middle aquifer and top of the lacustrine unit. The borehole for the deep extensometer was drilled to 1,205 ft below land surface, which is about 300 ft below the lacustrine unit, corresponding to the top of the lower aquifer. Inclinometer measurements made at depth intervals of about 100 ft during drilling indicate that the shallow and deep boreholes deviated from vertical by less than 0.5 and 1.0 degree, respectively. Riley (1986) noted that extensometer boreholes should be vertically aligned to prevent stick-slip friction between the measuring element and the casing. Excessive stick-slip friction can degrade extensometer measurements.

A 6.6-inch outer-diameter steel casing was anchored in cement at the bottom of each borehole (fig. 5). A series of three slip joints was installed along the well casing string. Each slip joint allowed the casing string to change length by as much as 4 ft, and each joint was precompressed by 1 ft to allow vertical displacement in either direction. The slip joints were used to minimize negative skin friction. Negative skin friction occurs between the casing and sediments adjacent to the borehole and can cause the extensometer instruments to under record compaction or expansion by redistributing vertical stresses near the borehole. To further reduce negative skin friction, the

annular space between the casing and the borehole was grouted with low-friction bentonite.

A 12-inch diameter surface casing was placed to about 48 ft below land surface in each borehole to prevent infiltration of surface runoff. A 2-inch steel extensometer pipe (the measuring element) was placed inside each casing and rested at the bottom of the borehole. The bottom of the extensometer pipe was about 700 ft below land surface in the shallow extensometer and about 1,180 ft below land surface in the deep extensometer.

A 20- by 15-foot shelter was constructed over the dual extensometer. An instrument table was positioned over both extensometers. The table was mounted on three 4-inch diameter steel legs that were cemented in holes bored to a depth of 16 ft below land surface. To minimize the effect of shallow sediment movement on the extensometer measurements, each table leg was encased in a 6-inch polyvinyl-chloride (PVC) casing, and cardboard forms were placed around the table legs and the 12-inch diameter extensometer surface casings to decouple them from the concrete pad constructed for the shelter foundation. Because the instrument table legs were anchored 16 ft below land surface, the shallow extensometer measured vertical deformation between 16 and 700 ft below land surface, and the deep extensometer measured vertical deformation between 16 and 1,180 ft below land surface.

The extensometer pipe was supported above ground by a fulcrum assembly consisting of a fulcrum arm positioned on an arm support welded to the outside of the 12-inch surface casing and balanced with lead counterweights (fig. 6). Following the guidelines of Riley (1986), the weight of the extensometer pipe was counterbalanced to minimize flexing of the pipe to prevent the pipe from contacting the well casing. The asymmetrical positioning of the fulcrum arm afforded the arm a mechanical advantage of about 8:1 because it reduced the required counterweight from 1,440 to 180 pounds for the shallow extensometer and from 3,360 to 420 pounds for the deep extensometer.

Dual-Extensometer Instrumentation

Vertical deformation (compaction and expansion) of the aquifer system was measured by recording the movement of the instrument table relative to the top of the extensometer pipe using digital and graphical methods. A linear potentiometer (transducer) with a resolution of about 0.0001 was the primary

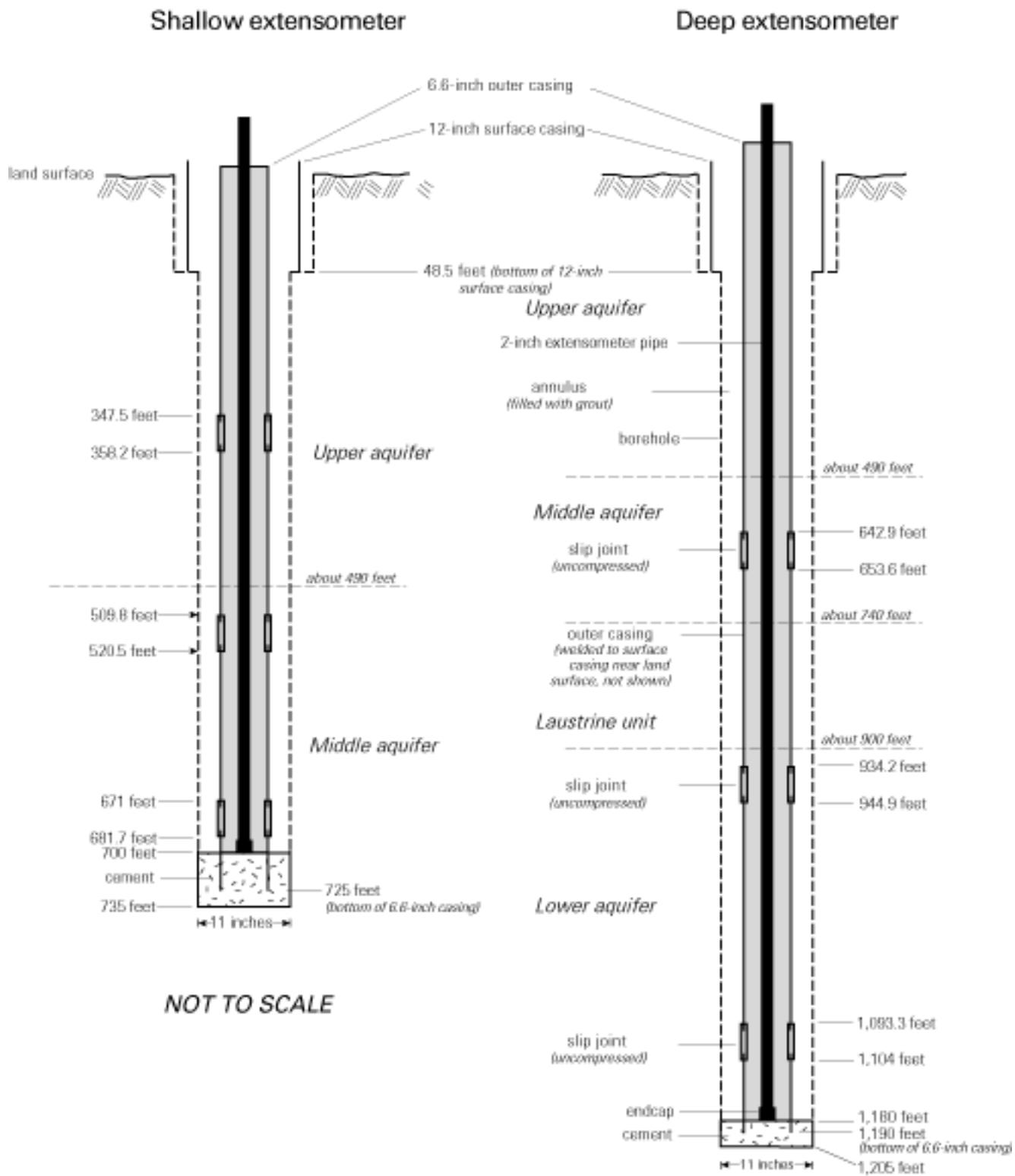


Figure 5. Below-ground installation of the dual extensometer at the Avenue K-8 and 5th Street West well field in Lancaster, Antelope Valley, California.

instrument for each extensometer. The top of the linear potentiometer was secured to the instrument table, and the bottom was secured to the extensometer pipe (fig. 6). As the instrument table moved relative to the extensometer pipe, the linear potentiometer output a voltage proportional to the displacement. The output voltage was recorded on an electronic data logger inside the shelter.

Analog dial gages also were used to measure vertical deformation. The dial gages were attached to pieces of angle aluminum affixed to the instrument table (fig. 6). A spring-controlled stem protruding from the bottom of the dial gage rested on a fixed reference surface attached to the extensometer pipe. The stem compressed or expanded as the instrument table moved relative to the fixed reference surface. The analog dial gage can be read to 0.0001 inch. The dial-gage readings

were not recorded electronically and therefore were read during site visits. The readings were used to check linear potentiometer drift and to apply corrections after adjustments to the extensometers.

Steven's Type-F chart recorders were used to record vertical deformation graphically to ensure data were collected if the linear potentiometer or the electronic data logger failed. Movement of the instrument table relative to the extensometer pipe was recorded by a drum rotating against a clock-driven pen (Riley, 1986). A counterweight, suspended from the gear train, balanced the chart drum against the force exerted on the recorder drive pulley by the extensometer pipe. Vertical-deformation data recorded on the chart can be read to 0.001 ft. The chart recorder can be operated for 32 days before the chart has to be replaced.

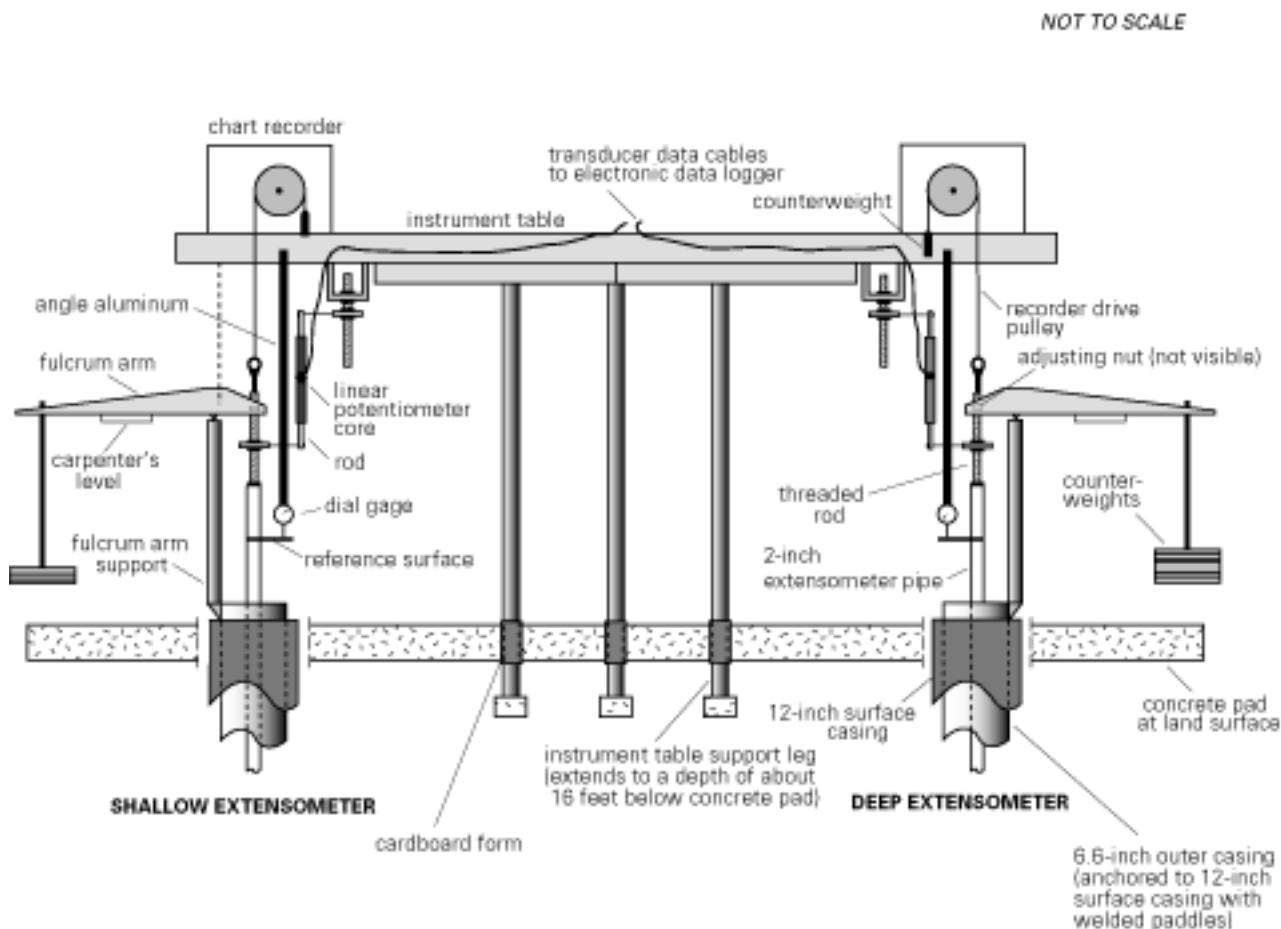


Figure 6. Above-ground installation of the dual extensometer at the Avenue K-8 and 5th Street West well field in Lancaster, Antelope Valley, California.

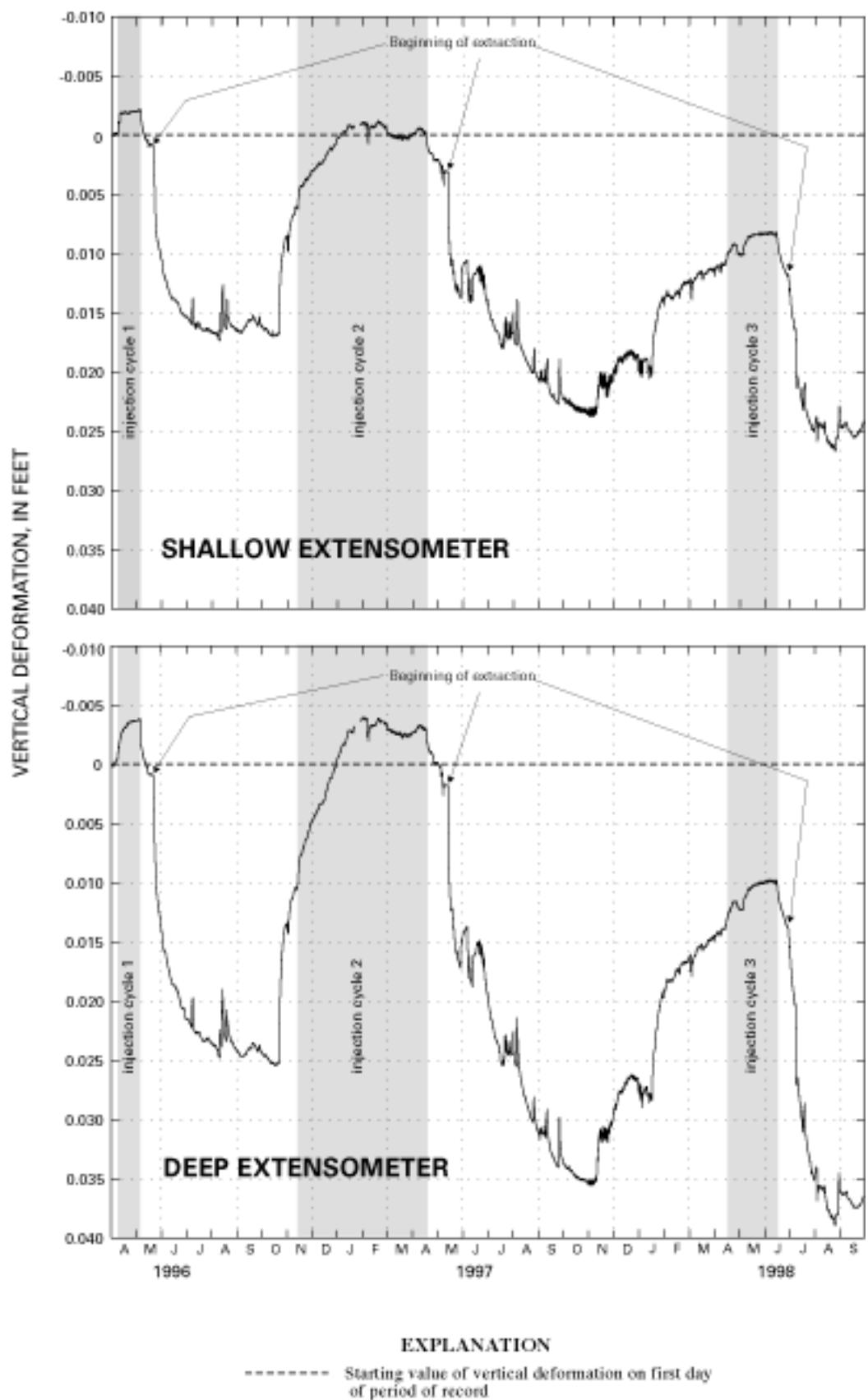


Figure 7. Vertical deformation of the aquifer system measured at the shallow (7N/12W-27F9) and deep (7N/12W-27F10) extensometers in Lancaster, Antelope Valley, California, April 1996 through September 1998.

Data Collection and Processing

Collection of vertical-deformation data began in early April 1996, after a series of load tests were done to calibrate the linear potentiometers. The load tests were done by adding and subtracting fixed increments of counterweights to the fulcrum arms and recording the changes in output from the linear potentiometers and analog dial gages. A generalized least-squares regression was applied to the load-test data to derive equation 1, which converts the potentiometer output (in millivolts) to vertical deformation (in feet):

$$VD = YI + (S)(RM), \quad (1)$$

where

- VD* is the computed vertical deformation, in feet;
- YI* is the *y*-intercept of the least-squares regression equation, in feet;
- S* is the slope of the least-squares regression equation, in feet per millivolt; and
- RM* is the ratiometric output of the linear potentiometer at a specific time, in millivolts.

The *y*-intercept values derived from the load-test data for equation 1 for each extensometer were adjusted slightly to set the starting value of vertical deformation to zero on the first day of the period of record. The values of vertical deformation were cumulative to April 2 and April 3, 1996, for the deep and shallow extensometers, respectively.

Vertical deformation of the aquifer system was measured at the shallow (7N/12W-27F9) and deep (7N/12W-27F10) extensometers (fig. 7). The downward trends in figure 7 indicate compaction of the aquifer system, and the upward trends indicate expansion of the aquifer system. Positive values indicate net compaction relative to the first day of the period of record and negative values indicate net expansion.

Weekly to bimonthly field visits were made to the dual extensometer from April 1996 through September 1998. The frequency of the field visits was determined by the magnitude and rate of vertical deformation and by the data-logger recording interval specified during the previous field visit. Data were recorded at increasingly longer intervals because it was determined that fewer measurements would not decrease data quality. The recording interval ranged from 1 minute on the first day of the cycle 1 injection (April 8, 1996) to 15 minutes for the cycle 3 extraction (July 1, 1998).

Several tasks were done during each field visit. Data stored on the data logger were retrieved to a laptop computer and checked to ensure the extensometers were operating properly. The analog dial-gage and linear potentiometer readings were recorded and compared to evaluate the performance of the dual extensometers. Charts were replaced on the chart recorders. The data-logger clock was synchronized with Coordinated Universal time. During many of the field visits, the fulcrum arms of the dual extensometer were adjusted to maintain constant tension on the extensometer pipe.

On completion of each field visit, the data were entered into the USGS National Water Information System (NWIS) database. Computer programs in the NWIS database used equation 1 to convert the linear potentiometric ratios to feet. Datum and time-shift corrections were applied to the converted data to account for disturbances to the extensometer during field visits and linear potentiometer drift.

GROUND-WATER-LEVEL MONITORING

Water-level changes associated with direct well injection and extraction were monitored in a network of 13 active or abandoned production wells (including the two wells used for injection) and 10 nested piezometers located at three sites (fig. 8). The piezometers and most of the wells were within 2 mi of the injection site. Water levels were monitored in three wells (6N/12W-9H3, 12M2, and 16A2) within about 3 mi southward from the injection site; well 12M2 is more southeasterly, which is the general direction of ground-water flow (Carlson and others, 1998).

The construction data in table 1 show that most of the piezometers and production wells in the water-level monitoring network are screened (perforated) within the upper and middle aquifers, the zones of the direct well injections. Three piezometers (7N/12W-27F5, 27H5, and 27P5) were screened solely in the lower aquifer. One production well (7N/12W-27F3) was screened in all three aquifers. The construction data in table 1 show that the screened intervals of most of the piezometers are fairly short (20 ft), whereas the screened intervals of the production wells are fairly long (200 to 800 ft).

Construction of Nested Piezometers

Two sets of nested piezometers were constructed for the study, each containing four 2-inch wells in a single borehole. Boreholes were drilled using direct-rotary drilling methods (Lapham and others, 1997).

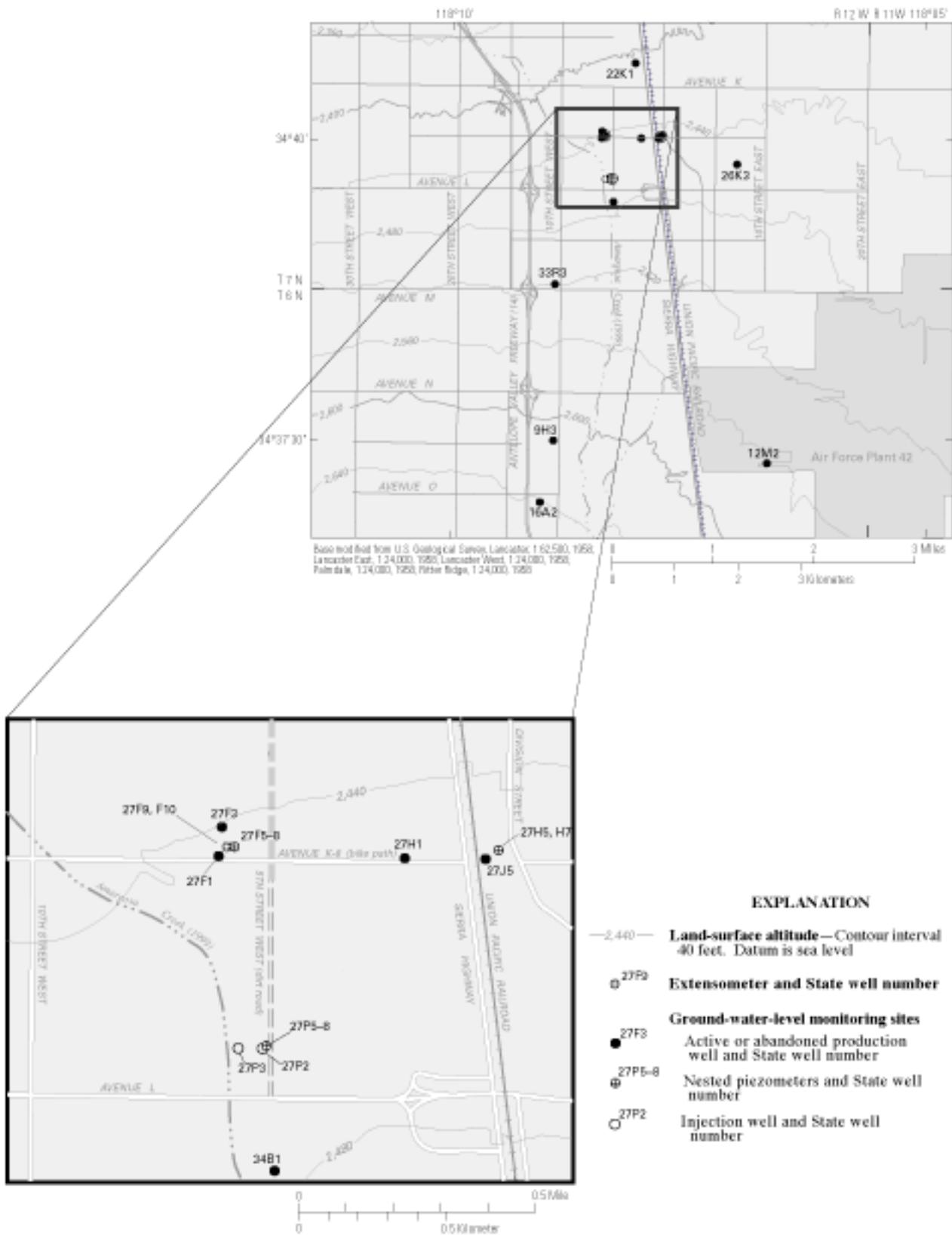


Figure 8. Locations of ground-water-level monitoring sites used for the injection, storage, and recovery study at Lancaster, Antelope Valley, California.

14 **Table 1.** Well-construction data for wells used in the injection, storage, and recovery study at Lancaster, Antelope Valley, California, September 1995 through September 1998

[State well number: See well-numbering system in text. Location of wells are show in figures 3, 8, and (or) 37. USGS, U.S. Geological Survey. USGS site identification number: The unique number for each site is based on the latitude and longitude of the site, which is referenced to the North American Datum of 1927 (NAD27). First six digits are latitude, next seven digits are longitude, and final two digits are a sequence number to uniquely identify each site. Altitude of land surface in feet above sea level. Use of well: AB, abandoned; EXTM, extensometer; INDS, industrial supply; PIEZ, piezometer; PS, public supply. Depth drilled, casing depth, and screened (perforated) interval in feet below land surface. Screened (perforated) intervals: depth of top and bottom of well screen or perforations; screened or perforated throughout entire interval unless denoted by asterisk (*). The extensometers and piezometers were installed by the U.S. Geological Survey. Aquifer zones: U, upper; M, middle; L, lower; UNK, unknown. Type of data included in this report for each well: BP, barometric pressure; C, compaction; F, flow; WC, water chemistry; WL, water level. —, no data]

State well number	USGS site identification number	Local well name	Altitude of land surface	Use of well	Year of construction	Depth drilled	Well casing		Screened interval depth	Aquifer zone perforated	Type of data included in this report	
							Diameter (inches)	Depth				
6N/12W -9H3	343727118085202	—	2,610	PS	1992	1,015	16	910	500–900	M	WL	
	-12M2	DW8-1	2,560	INDS	1976	810	14	801	500–801	M	WL	
	-16A2	343655118090001	—	PS	—	(¹)	—	(¹)	—	UNK	WL	
7N/12W-15R2	344123118075501	4-9	2,386	PS	1953	670	14	670	466–670	U, M	WC	
	-15R3	344130118075701	4-17	PS	1958	1,227	14	1,227	480–1,227*	U, M, L	WC	
	-15R4	344125118075801	4-26	PS	1965	700	14	693	235–693	U, M	WC	
	-21C2	344107118092401	4-12	PS	1955	639	14	639	300–639	U, M	WC	
	-21C4	344109118092601	4-25	PS	1964	800	14	640	200–640	U, M	WC	
	-21C5	344109118092201	4-38	PS	1974	750	16	733	210–720	U, M	WC	
	-22B2	344120118081301	4-5	PS	1947	578	14	552	192–552	U, M	WC	
	-22K1	344043118080301	—	AB	—	400	8	—	—	U	WL	
	-26K3	343951118065902	4-31	AB	1969	770	16	687	310–674	U, M	WL	
	-27F1	344004118082401	—	AB	—	—	—	(²)	—	UNK	WL	
	-27F2	344005118081801	4-43	PS	1988	1,210	16	1,202	400–1,202	U, M, L	WC	
	-27F3	344006118082601	4-44	PS	1988	1,220	16	1,202	400–1,202	U, M, L	WC, WL	
	-27F5	344005118082201	5K8-PZ1	2,441.6	PIEZ	1996	1,183	2	935	905–925	L	WC, WL, BP
	-27F6	344005118082202	5K8-PZ2	2,441.6	PIEZ	1996	1,183	2	735	705–725	M	WC, WL
	-27F7	344005118082203	5K8-PZ3	2,441.6	PIEZ	1996	1,183	2	535	505–525	M	WC, WL
	-27F8	344005118082204	5K8-PZ4	2,441.6	PIEZ	1996	1,183	2	425	395–415	U	WC, WL
	-27F9	344005118082205	5K8-EX1	2,441.6	EXTM	1996	735	7	725	—	—	C
	-27F10	344005118082206	5K8-EX2	2,441.6	EXTM	1996	1,205	7	1,190	—	—	C
	-27H1	344004118075901	—	AB	1949	500	14	500	189–500	U	WL	
	-27H3	344008118074701	4-33	PS	1971	730	16	710	260–700	U, M	WC	
	-27H5	344003118074801	DK8-PZ1	2,449	PIEZ	1992	1,120	2	1,120	1,080–1,100	L	WC, WL
	-27H7	344003118074803	DK8-PZ3	2,449	PIEZ	1992	1,120	2	724	684–704	M	WL

See footnote at end of table.

Table 1. Well-construction data for wells used in the injection, storage, and recovery study at Lancaster, Antelope Valley, California, September 1995 through September 1998—Continued

State well number	USGS site identification number	Local well name	Altitude of land surface	Use of well	Year of construction	Depth drilled	Well casing		Screened interval depth	Aquifer zone perforated	Type of data included in this report
							Diameter (inches)	Depth			
7N/12W-27J4	344002118074701	4-13	2,448	PS	1956	1,108	14	¹ 1,102	362–1,102	U, M	WC
-27J5	343903118074801	4-8	2,449	AB	1953	700	14	700	350–700	U, M	WL
-27J6	344003118074901	4-42	2,449	PS	1987	1,174	16	1,150	400–1,140	U, M, L	WC
-27P2	343943118081801	4-32	2,463	PS	1969	735	16	727	282–717	U, M	F, WC, WL
-27P3	343943118082101	4-34	2,462	PS	1972	740	16	720	280–710	U, M	F, WC, WL
-27P5	343943118081701	5L-PZ1	2,462.7	PIEZ	1998	918	2	910	890–910	L	WL
-27P6	343943118081702	5L-PZ2	2,462.7	PIEZ	1998	918	2	560	540–560	M	WL
-27P7	343943118081703	5L-PZ3	2,462.7	PIEZ	1998	918	2	460	440–460	U	WL
-27P8	343943118081704	5L-PZ4	2,462.7	PIEZ	1998	918	2	390	330–370	U	WL
-30B1	344028118112601	4-37	2,387	PS	1974	652	16	610	260–600	U, M	WC
-33R3	343848118085203	—	2,519	PS	1993	824	16	780	440–760	U, M	WL
-34B1	343931118081601	—	2,475	AB	1953	425	8	—	—	U	WL
-34N3	343848118083801	4-29	2,522	PS	1967	792	14	740	350–728	U, M	WC
-34N4	343851118083801	4-30	2,517	PS	1968	800	16	770	350–760	U, M	WC

¹ Depth, obtained from owner, is approximately 800 feet below land surface.

² Depth at least 750 feet below land surface; sounded March 1996.

³ Well casing filled with gravel to about 700 feet below land surface in early 1990s.

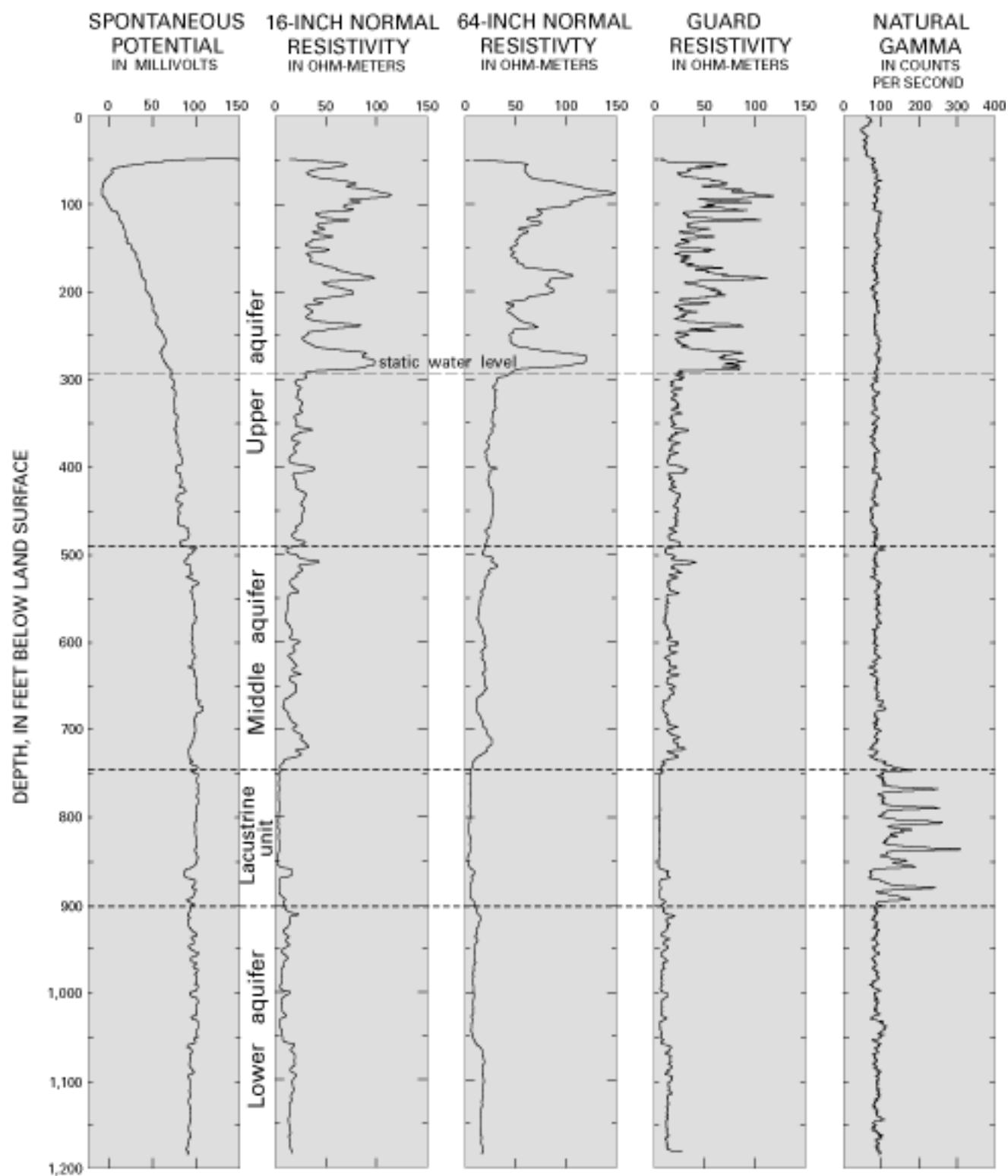


Figure 9. Geophysical logs, well-construction diagram, and lithologic log of the borehole for nested piezometers 7N12W-27F5-8 at the extensometer site in Lancaster, Antelope Valley, California. The color of the samples are described using numerical color designations from Munsell soil-color charts (Munsell Color, 1975).

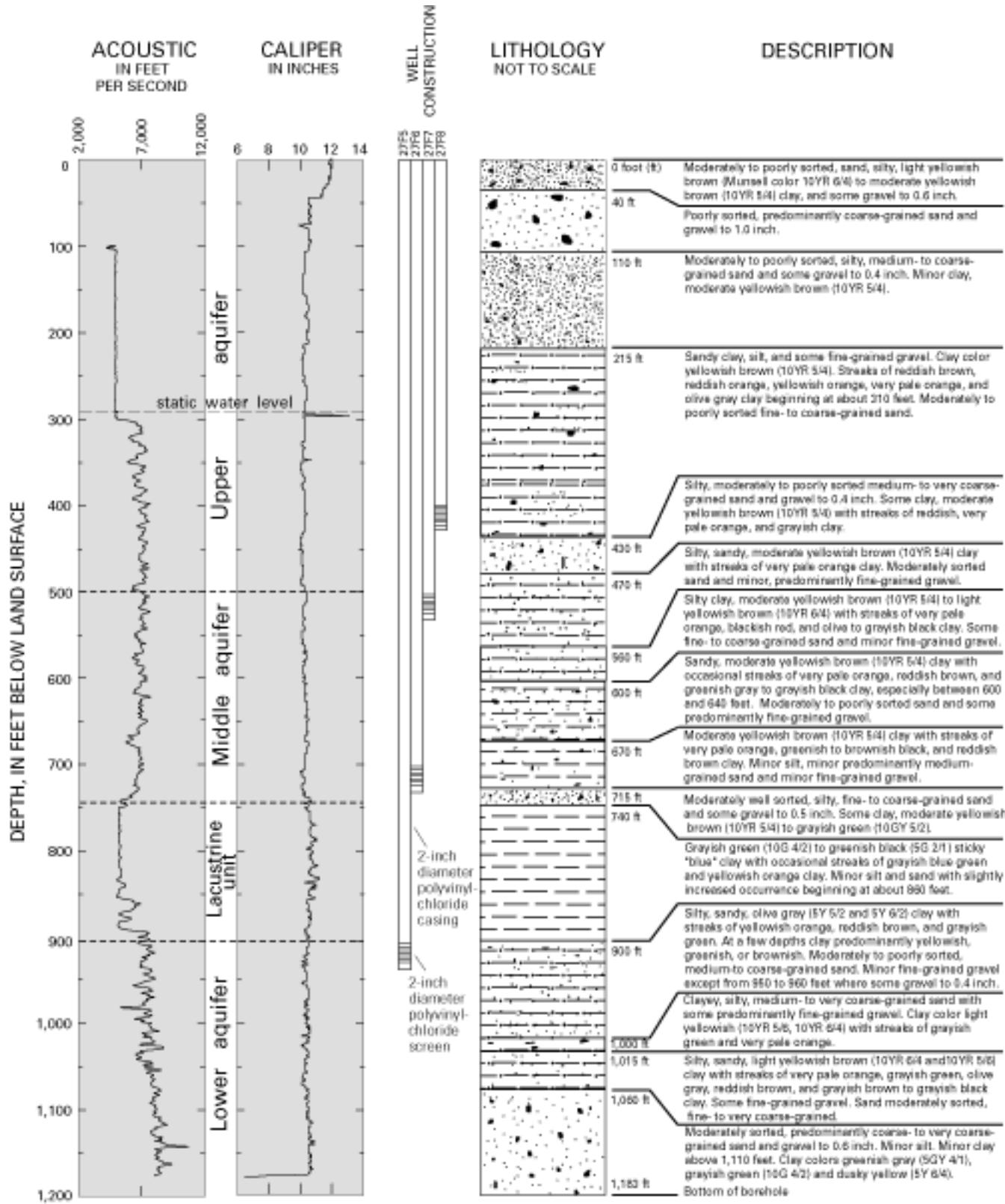


Figure 9.—Continued.

One set, wells 7N/12W-27F5–8, was installed in January 1996 adjacent to the extensometer (fig. 8) to monitor water-level changes in relation to vertical deformation of the aquifer system. The second set, wells 7N/12W-27P5–8, was installed in February 1998 approximately 80 ft northeast of well 7N/12W-27P2, the Avenue L and 5th Street West injection site (fig. 8). This set was installed near the injection wells to monitor water levels, help quantify the hydraulic properties of the aquifer system, and collect water-chemistry samples. Another set of nested piezometers (including 7N/12W-27H5 and 27H7) was installed in 1992 at the LACDPW Avenue K-8 and Division Street well field, about 0.66 mi northeast of the injection site (fig. 8).

As the boreholes were drilled, samples of cuttings, brought to the surface by circulating water-based drilling fluid, were collected approximately every 5 ft of the borehole depth. The drill cuttings from the borehole at the extensometer site were used to create a lithologic log for that site (fig. 9). Geophysical surveys were done for each site after the boreholes were drilled. Spontaneous potential, 16- and 64-inch normal resistivity, guard resistivity, natural gamma, acoustic and caliper logs were collected for the borehole at the extensometer site (fig. 9), and spontaneous potential, 16- and 64-inch normal resistivity, natural gamma, and caliper logs were collected for the borehole at the injection site (fig. 10). The logs were used to select the depth of each piezometer in the boreholes.

Construction data for each piezometer are listed in table 1 and shown in figures 11 and 12. The piezometers were assigned State and local well-identification numbers that correspond to the order of installation from deepest to shallowest. The piezometers were constructed with 2-inch diameter, schedule-40 or schedule-80 PVC casings and 20-foot long PVC screens; piezometer 7N/12W-27P8 was constructed with a 40-foot-long screen to reduce the chances of it going dry during extraction from the injection wells. A 12-inch diameter steel surface casing was installed at each site to prevent the infiltration of surface runoff.

Continuous Water-Level Measurements

Instrumentation

Submersible pressure transducers and data loggers (fig. 13) were installed in piezometers 7N/12W-27F5–8 at the extensometer site and 7N/12W-27P5–8 at the injection site (fig. 3) to continuously measure and record water levels. The transducers and data loggers

were temporarily installed in 2 piezometers (7N/12W-27H5 and 27H7) and 1 abandoned production well (7N/12W-27J5) at the LACDPW Avenue K-8 and Division Street well field (fig. 3) to continuously measure and record water levels during injection cycles 1 and 2. The transducers were protected and secured within lockable metal or concrete storage enclosures positioned over the nested piezometers and abandoned production well. The transducers were suspended from threaded rods mounted across the top of the surface casing and secured to the rod with wire cable grips and heavy-duty, vinyl-coated cloth tape to prevent slippage.

The transducers in the piezometers at the extensometer site and at the Avenue K-8 and Division Street well field sites had a pressure range of 0 to 5 lb/in², equivalent to a submergence depth of 0 to 11.5 ft, and were accurate to 0.01 ft. The transducers used at the injection site had a pressure range of 0 to 30 lb/in², equivalent to a submergence depth of 0 to 69.3 ft below the water surface, and were accurate to 0.07 ft. Both sets of transducers were vented to atmospheric pressure. To prevent moisture from condensing in the vent tubes and affecting the measurements or potentially damaging the sensitive electronics of the transducers, the open, or land-surface, end of the transducer vent tubes were placed either in desiccant-filled film canisters or in aneroid bellows supplied by the manufacturer.

The transducers were calibrated at the time of installation to derive a relation to convert transducer output (in millivolts) to depth to water below land surface. Transducer output was recorded at fixed depths over at least one-half the pressure range of the transducer. At each depth, 1-minute readings of transducer output were recorded until three consecutive, nearly identical readings were obtained. The transducer was positioned and secured at its set point, a submergence depth within the calibration range. A generalized least-squares regression equation was applied to the calibration data and the following equation was derived to convert transducer output to depth to water below land surface (*DBLS*):

$$DBLS = SP - (S)(mV), \quad (2)$$

where

- DBLS* is depth to water below land surface, in feet;
- SP* is the transducer set-point distance below land surface, in feet;
- S* is the slope of the least-squares regression equation, in feet per millivolt; and
- mV* is the recorded transducer output, in millivolts.

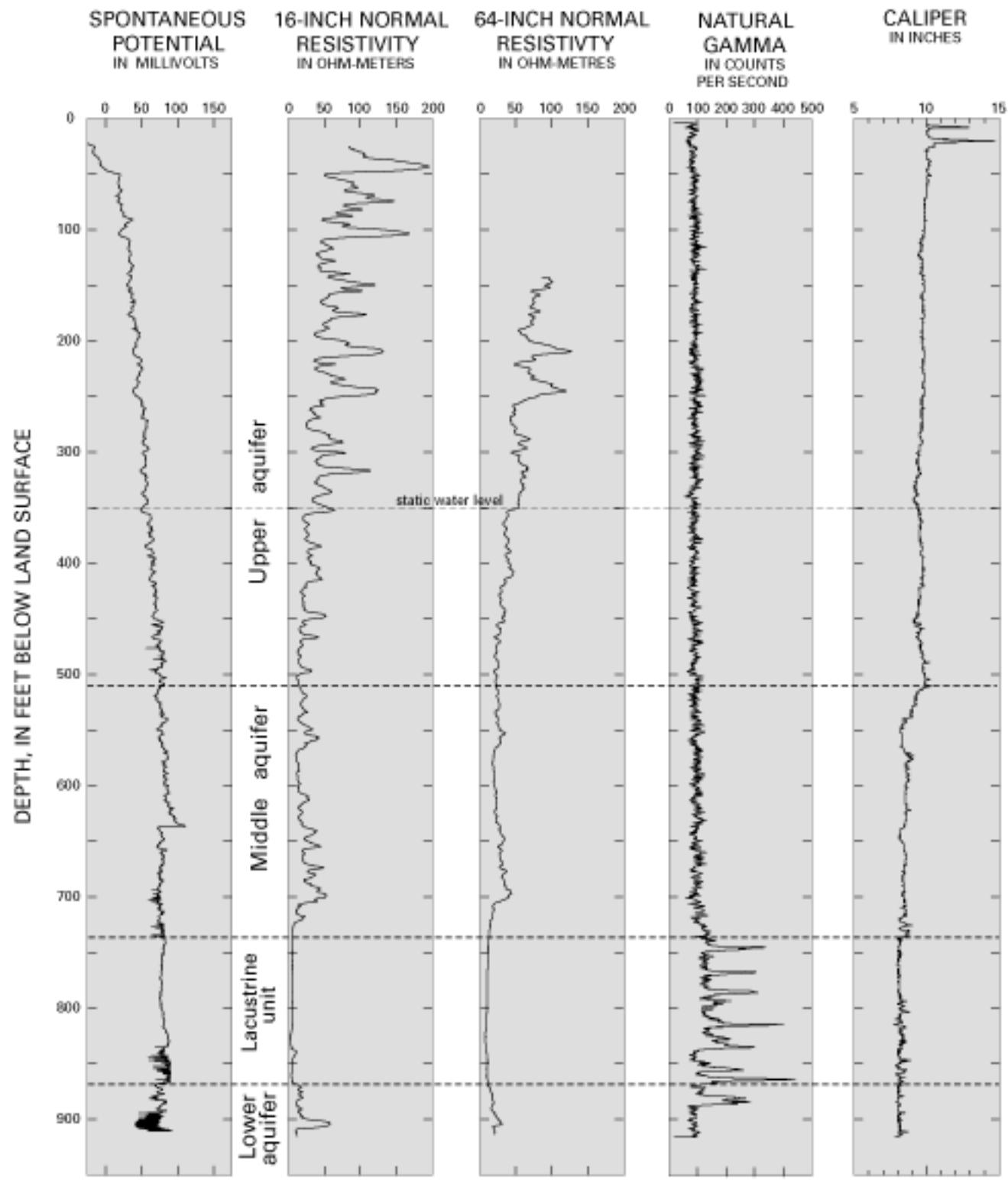


Figure 10. Geophysical logs of the borehole for nested piezometers 7N/12W-27P5-8 at the injection site in Lancaster, Antelope Valley, California.

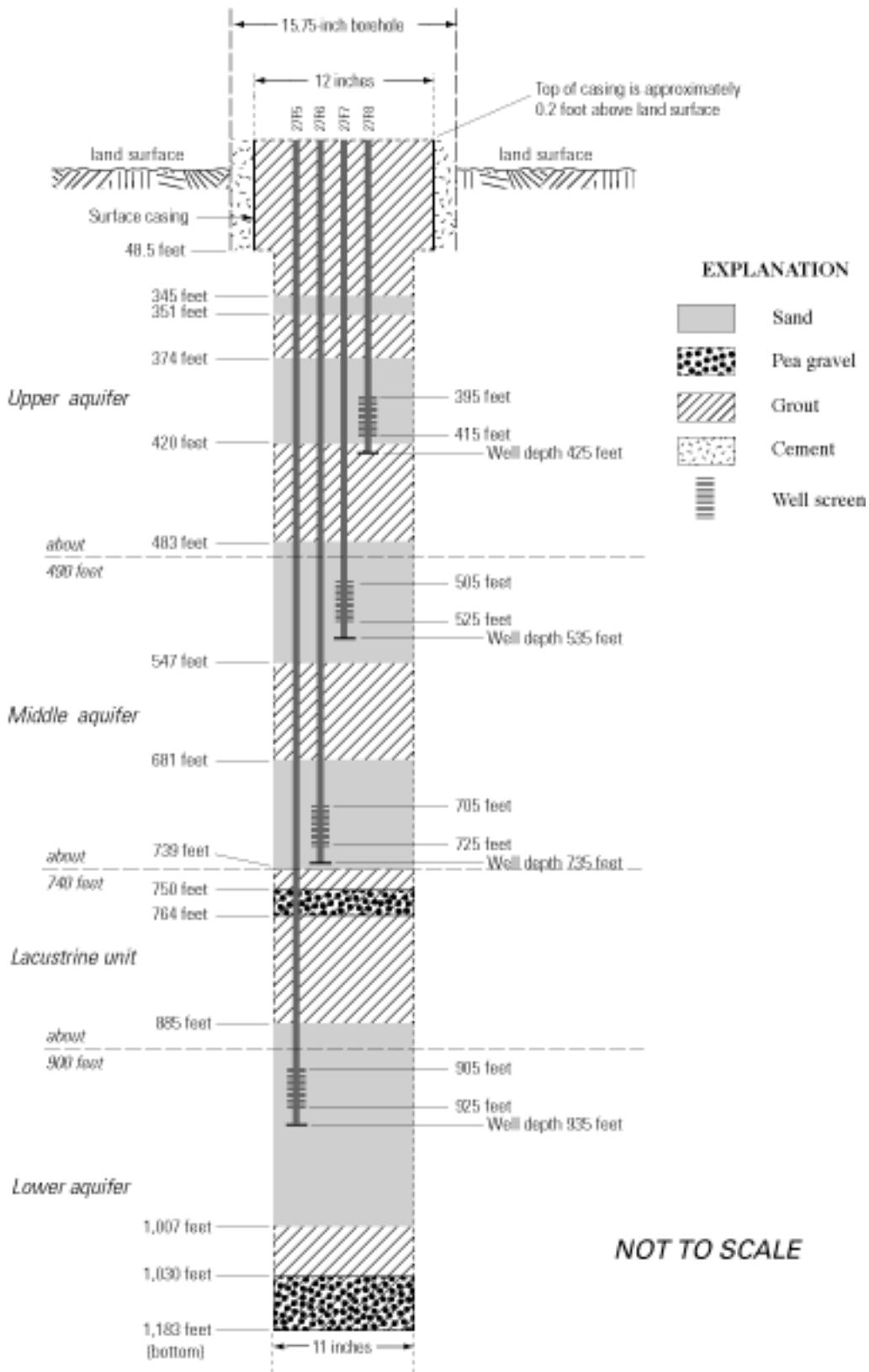


Figure 11. Well construction of nested piezometers 7N/12W-27F5-8 at the extensometer site in Lancaster, Antelope Valley, California.

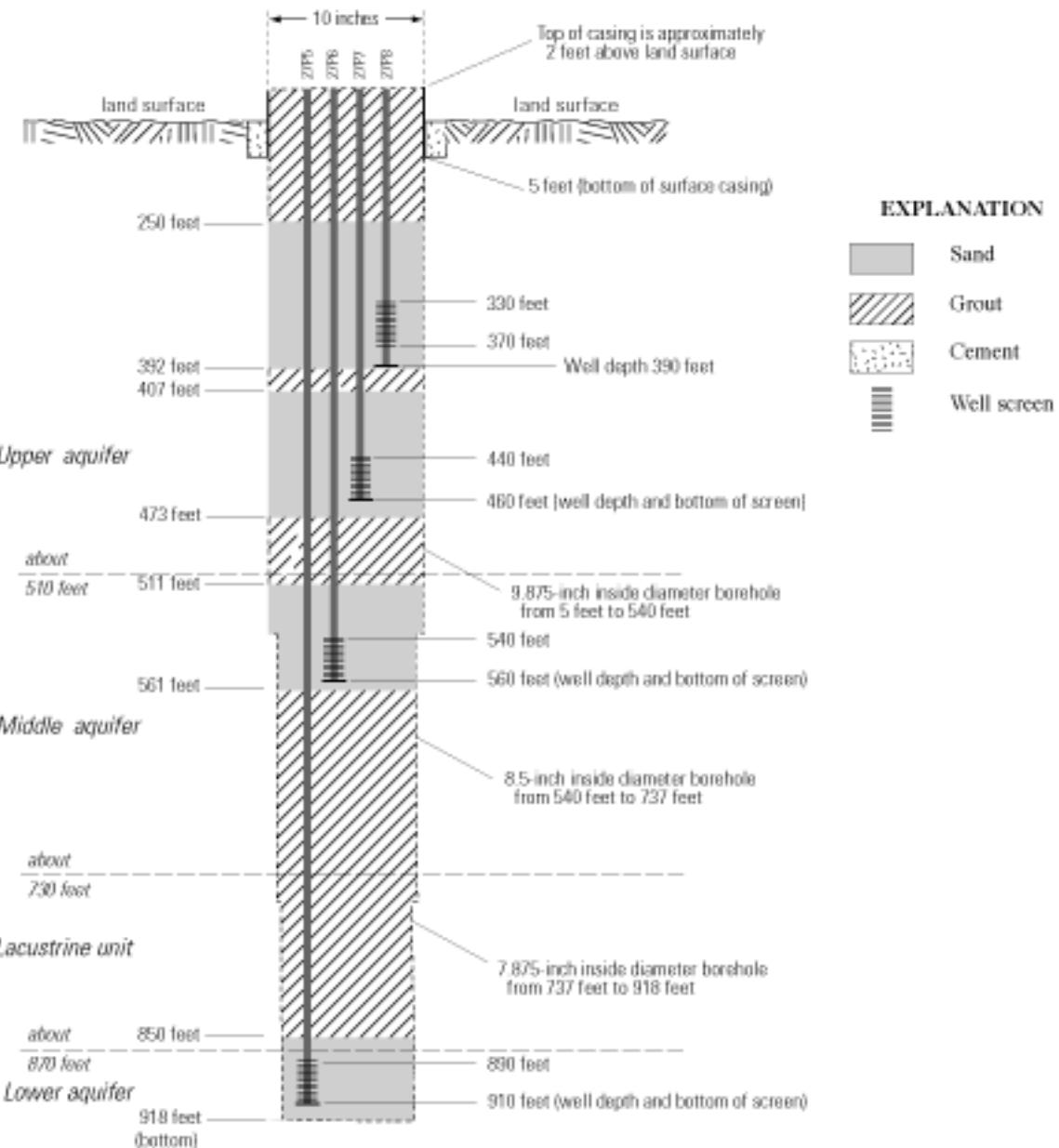


Figure 12. Well construction of nested piezometers 7N/12W-27P5-8 at the injection site in Lancaster, Antelope Valley, California.

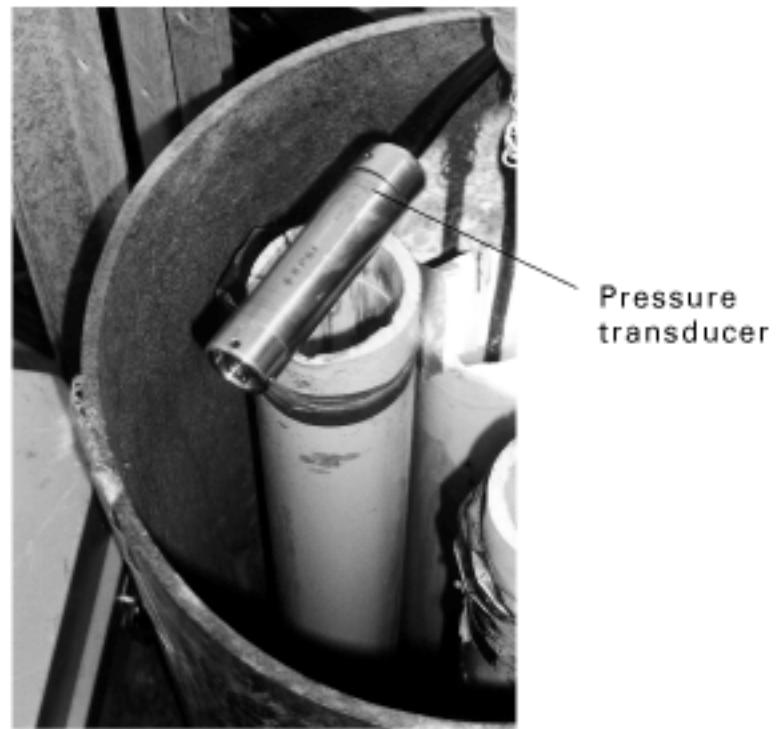


Figure 13. Typical pressure transducer and data-logger system used for recording continuous ground-water levels.

Barometric pressure was recorded at the extensometer site using an electronic pressure transmitter with a range of 600 to 1,600 millibars (fig. 14). Barometric pressure was not recorded at any specific well or piezometer but was assigned to piezometer 7N/12W-27F5 for the purpose of recording the data in the U.S. Geological Survey Automated Data Processing System (ADAPS) database. The data were used to evaluate the effect of barometric pressure on water levels and to monitor transducer performance. Water-level changes in deep wells normally are out of phase with barometric pressure changes because of the time it takes for air to move through the unsaturated zone. Continuous water-level data for deep wells that are in-phase with barometric pressure indicate either that the transducer vent tube is plugged or that the transducer has depressurized (Rummel, 1996).

Data Collection and Processing

Weekly to bimonthly field visits were made to the transducers from April 1996 through September 1998. Water-level and barometric-pressure data were downloaded from the data loggers to a laptop computer and checked to evaluate transducer performance. Water levels were measured with a calibrated electric tape and compared with water levels measured by the transducers; differences are attributed to transducer drift or to extraneous factors such as cable slippage.

The transducers periodically were recalibrated or repositioned during field visits. The transducers that had a fairly high cumulative drift (plus or minus 0.5 ft for a period of 6 months) were recalibrated using the same procedure applied during the initial installation. The transducers were frequently repositioned without

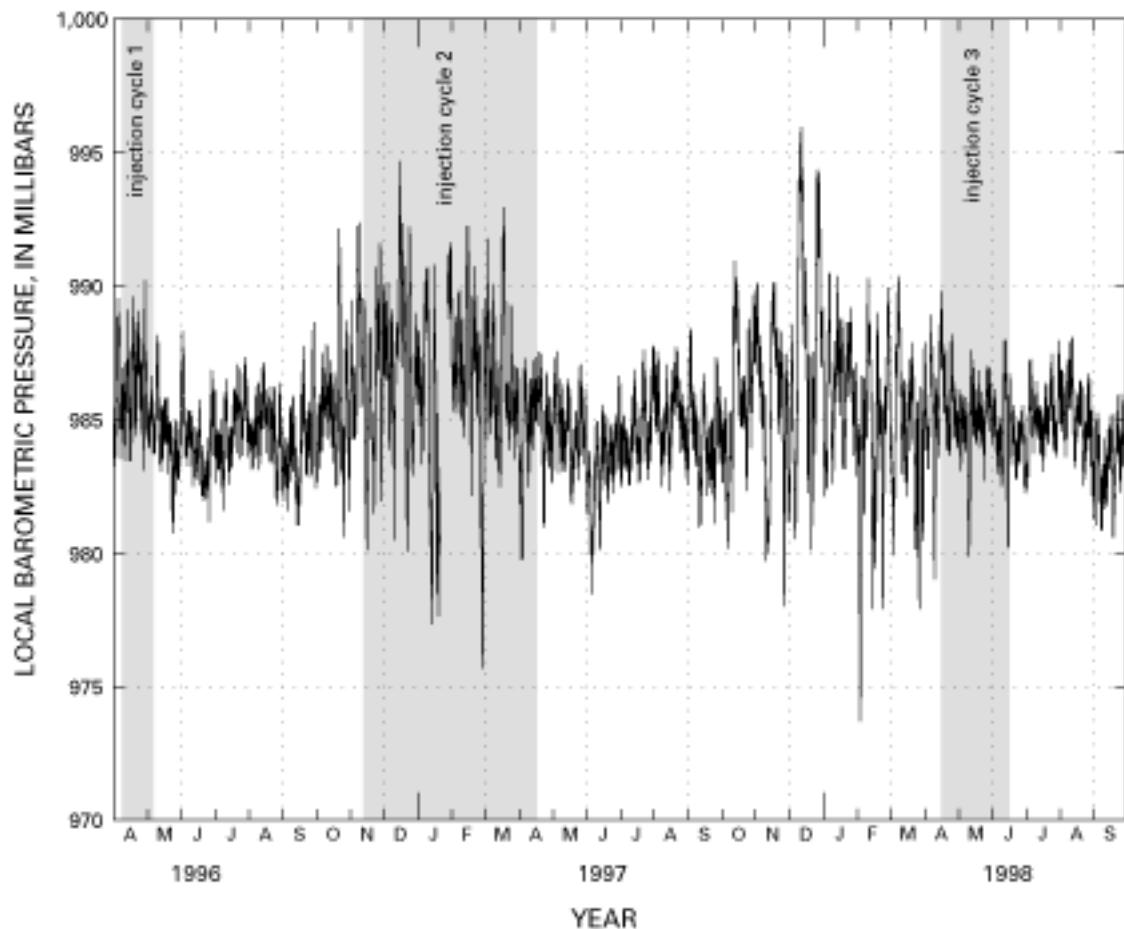


Figure 14. Local barometric pressure at the extensometer site in Lancaster, Antelope Valley, California, April 1996 through September 1998.

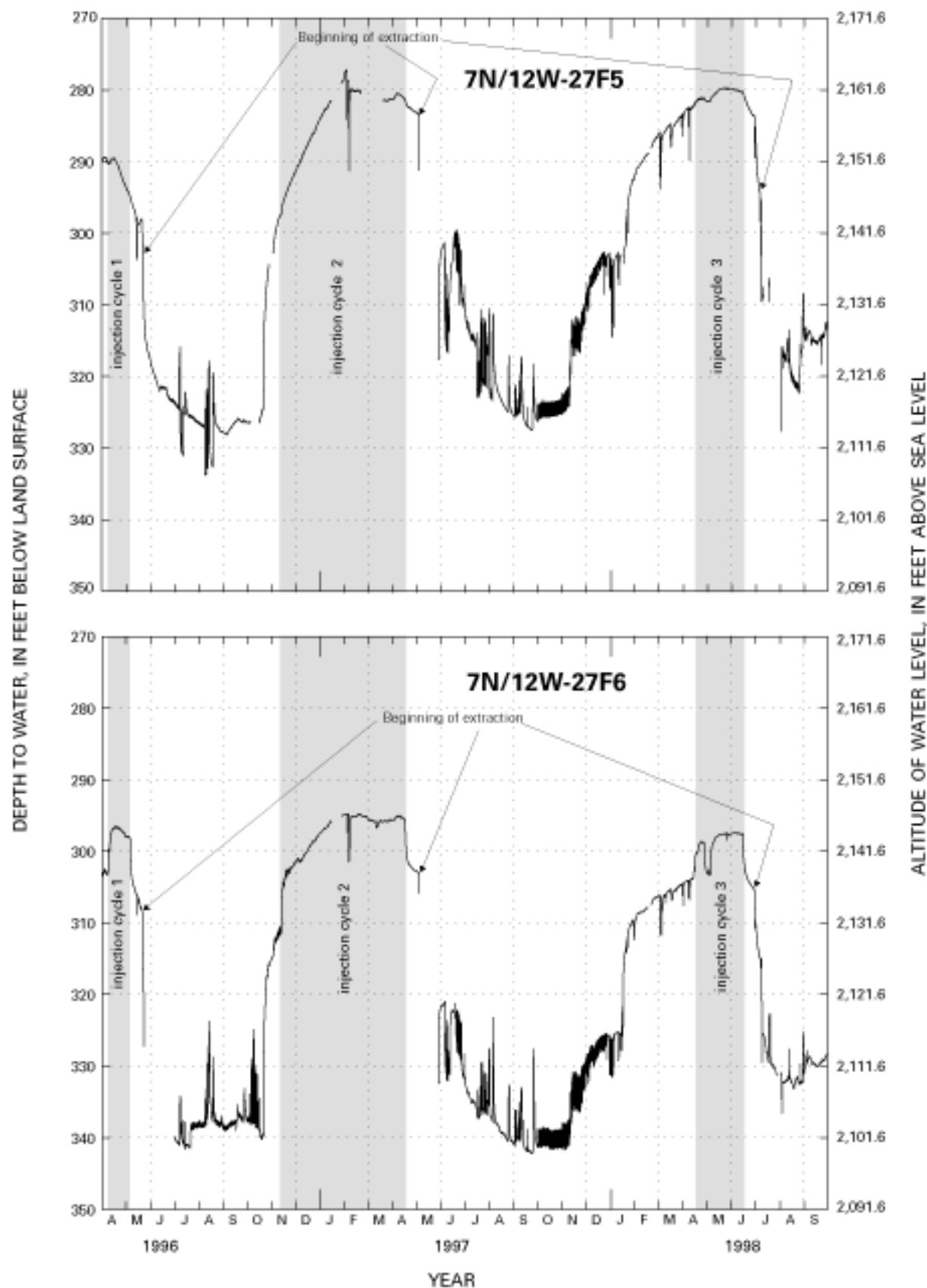


Figure 15. Ground-water levels recorded in piezometers 7N/12W-27F5–8 at the extensometer site in Lancaster, Antelope Valley, California, April 1996 through September 1998.

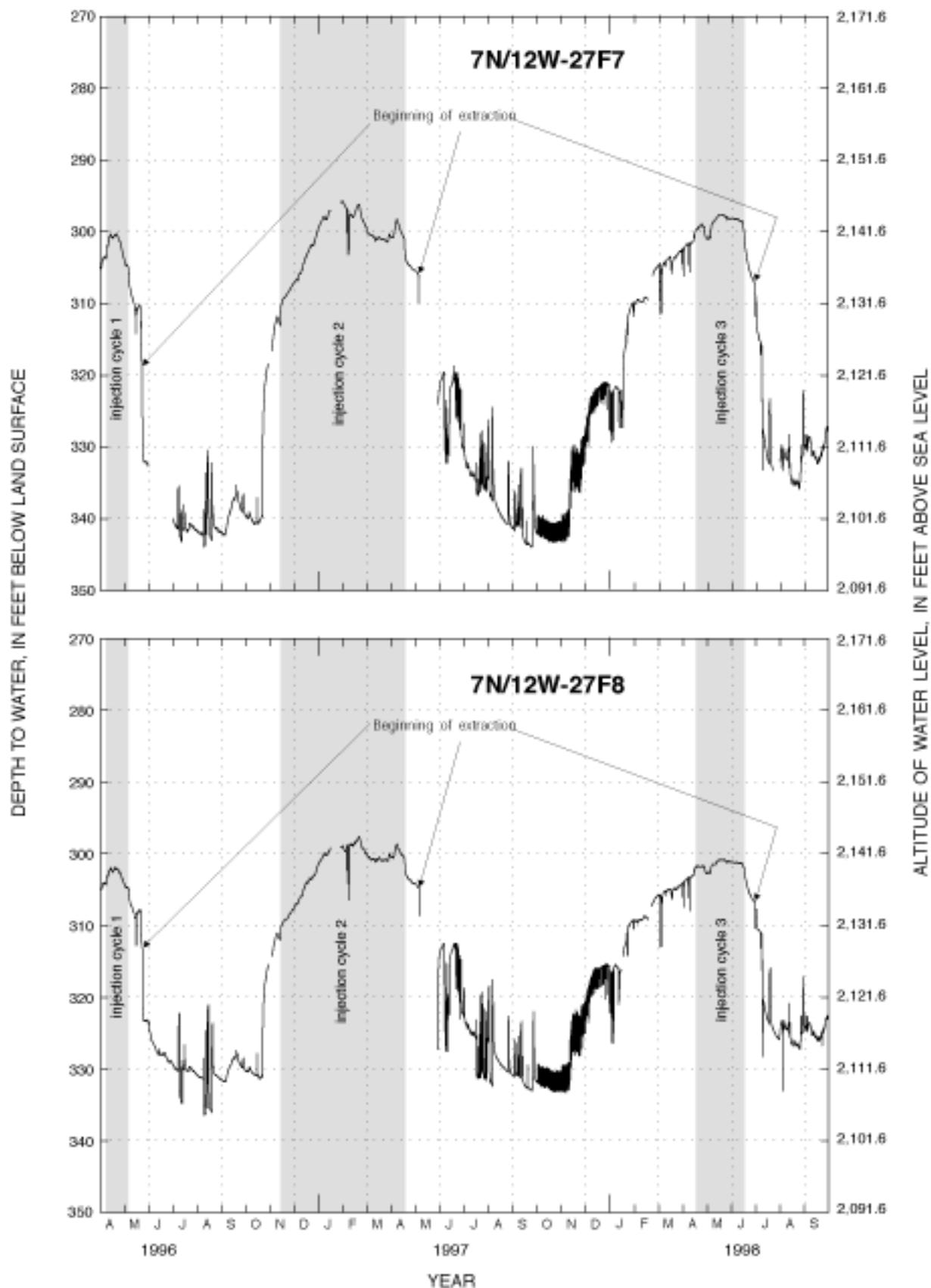


Figure 15.—Continued.

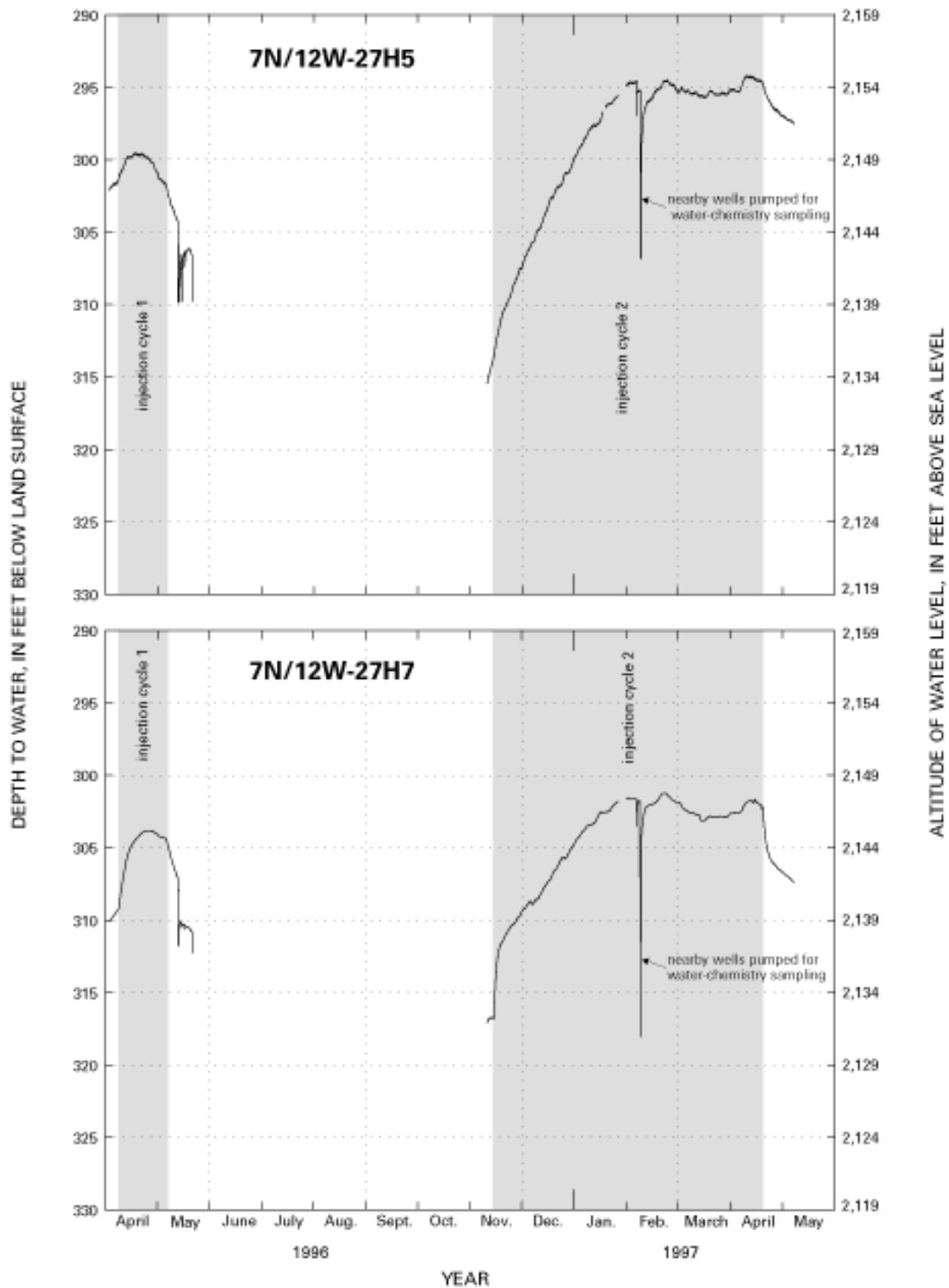


Figure 16. Ground-water levels recorded in piezometers 7N/12W-27H5 and 27H7 at the Avenue K-8 and Division Street well field in Lancaster, Antelope Valley, California, April 1996 through May 1997.

calibration to adjust for seasonal fluctuations in water levels. The repositioned transducers were not recalibrated because only the set point changed.

The continuous water-level data were processed and stored in the USGS NWIS database. Computer programs in the NWIS database were used to convert the transducer output (in millivolts) to depth to water below land surface using the equation derived from the calibration data. A datum correction was applied to the converted data to account for transducer drift.

Continuous water-level data are shown in figures 15–18. As these time-series plots show, there are many gaps in the recorded data. Some gaps represent periods when water levels declined below the set points of the transducers. Recording of the water-level data usually resumed when the transducer was repositioned during the next field visit. Other gaps may be due to power failures (including failures of backup batteries), temporary removal of a transducer for water-chemistry sampling, or transducer failure. Pumping at three of the

production wells at the Avenue K-8 and Division Street well field during the summer and autumn resulted in water levels that exceeded the length of the transducer cables in piezometers 7N/12W-27H5 and 27H7. The transducer installed in piezometer 7N/12W-27P7 failed after operating for less than 1 month and was not replaced. Any water-level data recorded for this piezometer are not included in this report.

Periodic Water-Level Measurements

Water levels were periodically measured in abandoned and active production wells where it was not feasible or desirable to install transducers for the continuous measurement of water levels. Water levels also were periodically measured in injection wells 7N/12W-27P2 and 27P3, but only during cycles 1 and 2. Water levels were not measured in the injection wells

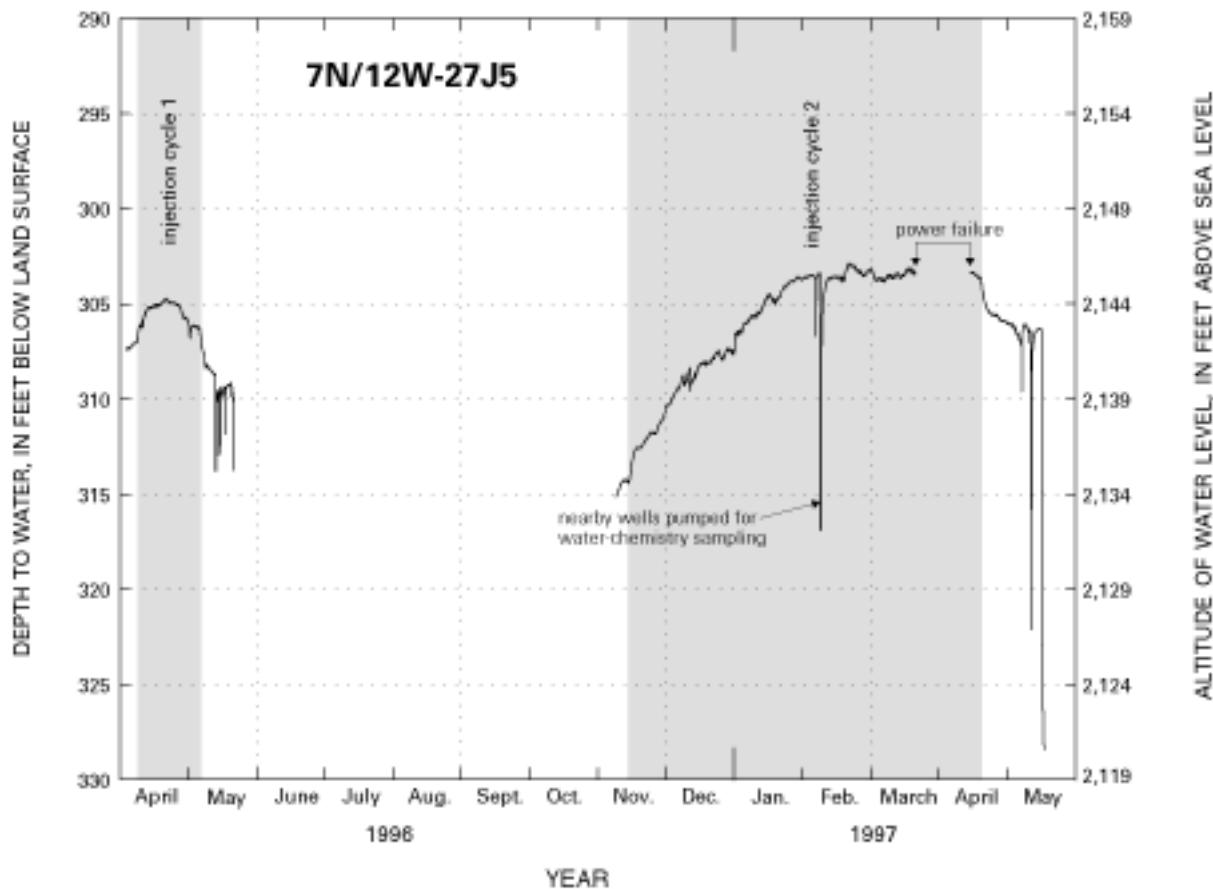


Figure 17. Ground-water levels recorded in abandoned production well 7N/12W-27J5 at the Avenue K-8 and Division Street well field in Lancaster, Antelope Valley, California, April 1996 through May 1997.

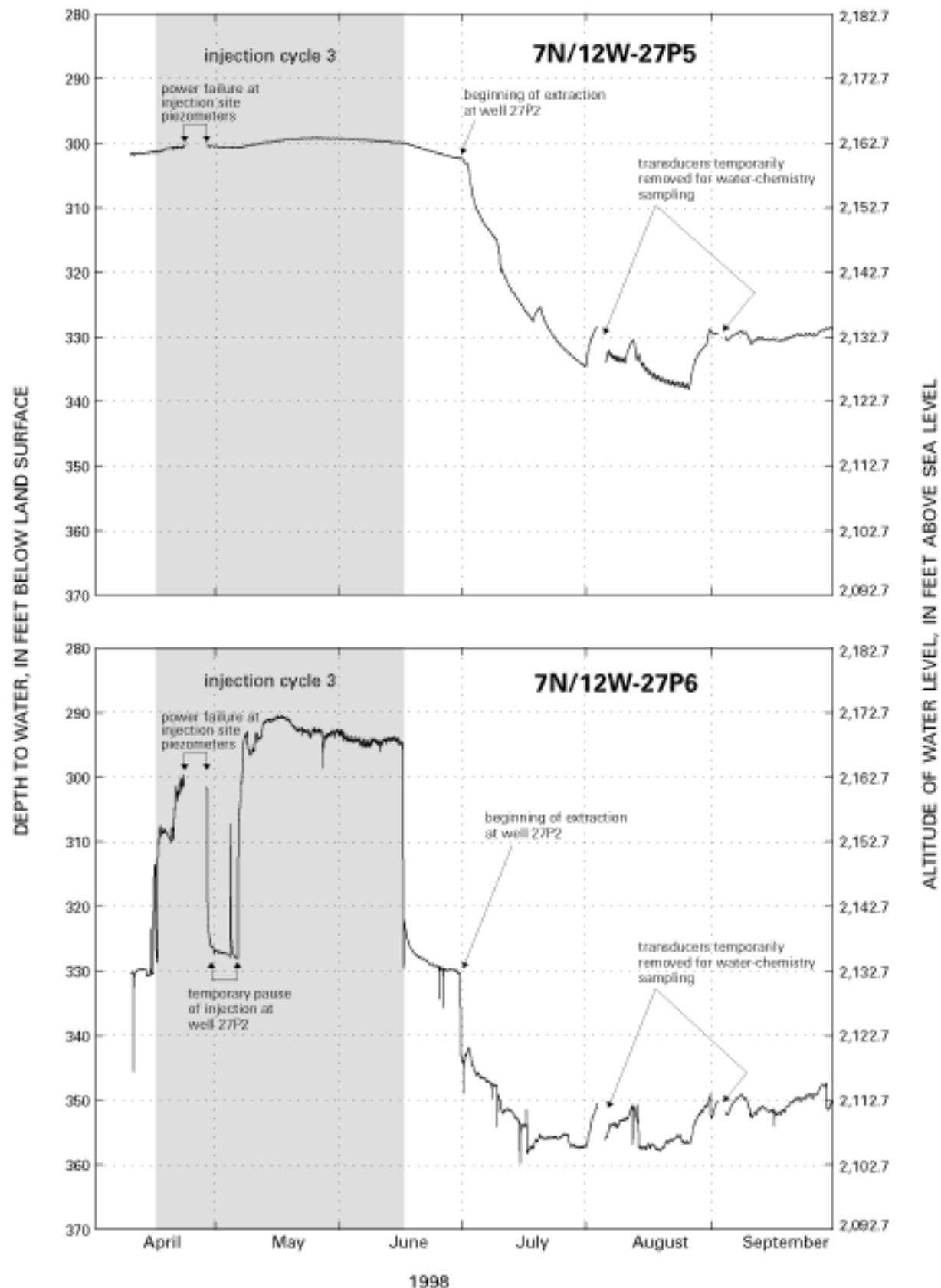


Figure 18. Ground-water levels recorded in piezometers 7N/12W-27P5, 27P6, and 27P8 at the injection site in Lancaster, Antelope Valley, California, April 1998 through September 1998.

during cycle 3 because the measuring points on these wells changed as a result of maintenance work.

Water levels in most of the wells were measured with a 500-foot calibrated electric tape with graduations of 0.01 ft; water levels in the remaining wells were measured using a graduated steel tape. The electric tape was used to measure most of the water levels because depth to water often exceeded 250 ft and measurements with a steel tape would have required more time. In some of the wells, measuring water levels with a steel tape would have been difficult owing to wet casings caused by condensation or cascading water. Water levels measured with both the electric tape and the steel tape generally were recorded to 0.01 ft, but are

reported to the nearest 0.1 ft in table 2. Water levels were measured at least twice for each well to ensure that the initial measurement was read and recorded correctly.

All periodic water-level data were stored in the USGS NWIS database. Water levels measured in nested piezometers and production wells within 2 mi of the injection site during periods of direct well injection were assigned a status code of "Z" in the database to denote direct well injection at the time of measurement. Periodic water-level measurements listed in table 2 also are given in figure 19 for all wells and piezometers except for piezometers 7N/12W-27F5–8 and 27P5–8.

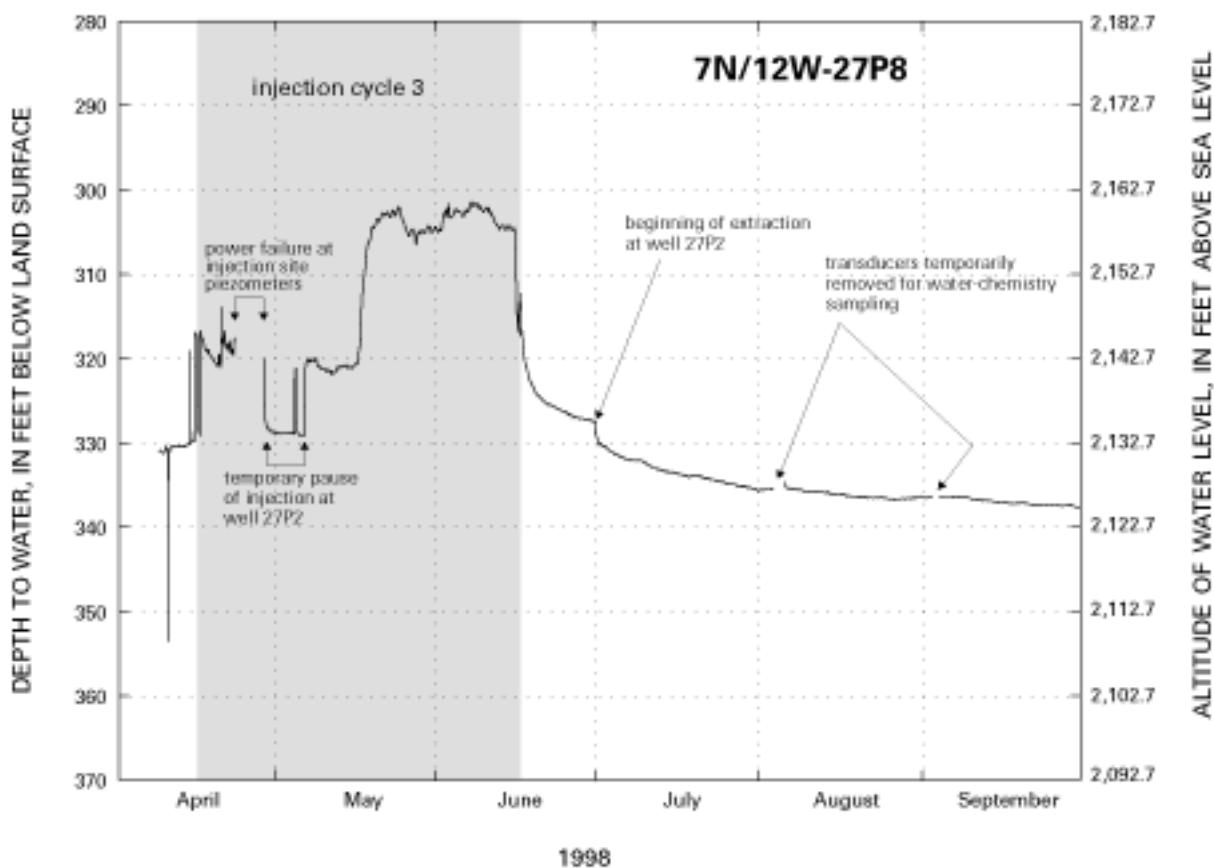


Figure 18.—Continued.

Table 2. Water levels in piezometers and wells measured for the injection, storage, and recovery study at Lancaster, Antelope Valley, California, September 1995 through September 1998

[Shading denotes water levels measured during injection periods; asterisk (*) by date denotes measurement during temporary pause (April 28 through May 6, 1998) in injection test. Depth to water in feet below land surface; altitude, altitude of potentiometric surface in feet above sea level. —, no data]

Measurement		Water level		Measurement		Water level		Measurement		Water level	
Date	Time	Depth	Altitude	Date	Time	Depth	Altitude	Date	Time	Depth	Altitude
6N/12W-9H3											
11-07-96	1201	445.3	2,165	02-20-97	1045	442.6	2,167	02-20-98	1241	442.8	2,167
11-12-96	1059	445.1	2,165	03-20-97	0851	443.0	2,167	03-19-98	1120	442.2	2,168
11-13-96	1509	444.8	2,165	04-14-97	0538	443.2	2,167	04-10-98	1019	442.5	2,168
11-14-96	0928	444.6	2,165	05-30-97	0507	445.4	2,165	04-29-98*	1124	442.8	2,167
11-15-96	1120	444.4	2,166	06-19-97	0527	445.6	2,164	05-27-98	1553	443.4	2,167
11-22-96	1230	444.5	2,166	09-02-97	1240	448.5	2,162	06-15-98	1358	444.3	2,166
12-10-96	0857	443.8	2,166	10-16-97	1448	446.6	2,163	07-01-98	1209	444.2	2,166
12-30-96	1014	443.2	2,167	11-24-97	1606	445.8	2,164	08-04-98	1313	445.8	2,164
01-29-97	1106	442.7	2,167	01-09-98	1600	443.5	2,167	09-03-98	1330	445.1	2,165
6N/12W-12M2											
11-07-96	1424	433.6	2,126	12-30-96	0922	433.2	2,127	06-19-97	0836	434.1	2,126
11-12-96	1010	433.3	2,127	01-29-97	1004	433.3	2,127	07-22-97	0942	434.5	2,126
11-13-96	1434	433.2	2,127	02-20-97	0959	433.4	2,127	10-17-97	0929	434.9	2,125
11-14-96	0848	433.0	2,127	03-19-97	1137	433.5	2,127	11-24-97	1503	434.9	2,125
11-15-96	1238	432.9	2,127	03-24-97	—	433.5	2,127	02-20-98	1125	434.6	2,125
11-22-96	1137	433.1	2,127	04-14-97	0726	433.7	2,126	04-10-98	0936	434.5	2,126
12-10-96	0830	433.0	2,127	05-06-97	0927	433.7	2,126	05-27-98	0850	434.6	2,125
6N/12W-16A2											
10-04-96	1251	469.4	2,171	11-12-96	1037	466.8	2,173	03-21-97	1355	463.9	2,176
10-18-96	0825	472.7	2,167	11-14-96	0953	466.4	2,174	04-14-97	0601	464.1	2,176
10-21-96	1013	468.3	2,172	11-15-96	1103	466.2	2,174	06-19-97	0617	469.6	2,170
10-22-96	1126	467.4	2,173	11-22-96	1206	465.8	2,174	09-02-97	1310	469.7	2,170
10-22-96	1643	466.8	2,173	12-30-96	0947	464.6	2,175	10-17-97	0848	469.0	2,171
10-31-96	1654	466.4	2,174	01-29-97	1037	463.8	2,176	11-24-97	1533	465.6	2,174
11-07-96	1132	466.6	2,173	02-20-97	1423	463.5	2,177	01-09-98	1623	463.1	2,177

Table 2. Water levels in piezometers and wells measured for the injection, storage, and recovery study at Lancaster, Antelope Valley, California, September 1995 through September 1998—Continued

Measurement		Water level		Measurement		Water level		Measurement		Water level	
Date	Time	Depth	Altitude	Date	Time	Depth	Altitude	Date	Time	Depth	Altitude
7N/12W-22K1											
04-01-96	1000	258.5	2,149	08-30-96	1350	263.0	2,144	04-22-97	0937	261.8	2,145
04-03-96	1027	258.1	2,149	10-04-96	1605	262.2	2,145	04-28-97	1031	261.8	2,145
04-04-96	1318	258.2	2,149	10-18-96	0736	263.1	2,144	05-06-97	0803	262.1	2,145
04-08-96	0856	257.8	2,149	10-21-96	0857	263.4	2,144	05-30-97	1019	261.8	2,145
04-08-96	1435	258.1	2,149	10-22-96	0811	263.4	2,144	06-19-97	0748	262.2	2,145
04-08-96	1604	258.1	2,149	10-22-96	1404	263.2	2,144	07-22-97	1012	263.2	2,144
04-08-96	1650	258.1	2,149	10-30-96	1148	262.7	2,144	09-02-97	1519	264.0	2,143
04-09-96	1019	258.0	2,149	11-07-96	0920	261.2	2,146	10-17-97	0801	264.2	2,143
04-09-96	1632	257.9	2,149	11-12-96	1230	262.4	2,145	01-09-98	1306	261.9	2,145
04-10-96	1221	257.8	2,149	11-13-96	0939	262.5	2,145	02-20-98	1026	261.3	2,146
04-10-96	1640	257.7	2,149	11-13-96	1634	262.4	2,145	03-18-98	1737	259.8	2,147
04-11-96	0709	257.7	2,149	11-14-96	1111	262.3	2,145	03-19-98	1455	260.1	2,147
04-11-96	1515	258.0	2,149	11-15-96	1216	262.2	2,145	04-10-98	0902	259.4	2,148
04-15-96	1639	258.4	2,149	11-22-96	1347	262.4	2,145	04-29-98*	1318	259.3	2,148
04-22-96	1632	258.3	2,149	12-10-96	1038	261.4	2,146	05-27-98	0817	259.0	2,148
05-02-96	1637	259.4	2,148	01-29-97	1249	258.6	2,148	06-15-98	1345	259.0	2,148
05-06-96	0807	259.4	2,148	02-20-97	1154	259.7	2,147	06-30-98	1217	262.0	2,145
05-06-96	1254	259.5	2,148	03-19-97	1312	261.5	2,146	08-04-98	1218	262.6	2,145
05-06-96	1613	259.6	2,147	04-14-97	0839	261.6	2,145	09-03-98	1252	262.6	2,144
05-13-96	1602	260.2	2,147	04-17-97	0804	261.7	2,145				
06-04-96	0721	260.7	2,146	04-17-97	1500	261.7	2,145				

Table 2. Water levels in piezometers and wells measured for the injection, storage, and recovery study at Lancaster, Antelope Valley, California, September 1995 through September 1998—Continued

Measurement		Water level		Measurement		Water level		Measurement		Water level	
Date	Time	Depth	Altitude	Date	Time	Depth	Altitude	Date	Time	Depth	Altitude
7N/12W-26K3											
04-01-96	1700	320.1	2,139	08-30-96	1226	331.4	2,128	04-17-97	1523	320.4	2,139
04-03-96	1116	320.0	2,139	10-04-96	1547	332.1	2,127	04-22-97	0757	320.9	2,138
04-04-96	1416	320.0	2,139	10-18-96	0752	332.5	2,127	04-28-97	—	321.4	2,138
04-08-96	1730	320.1	2,139	10-21-96	0844	332.4	2,127	05-06-97	0823	321.8	2,137
04-09-96	1005	319.9	2,139	10-22-96	0912	331.7	2,127	05-30-97	0548	329.7	2,129
04-09-96	1717	320.0	2,139	10-22-96	1455	331.5	2,128	06-19-97	0802	330.0	2,129
04-10-96	1235	319.9	2,139	10-31-96	1230	326.5	2,133	07-22-97	0737	330.9	2,128
04-10-96	1654	319.8	2,139	11-07-96	1005	325.2	2,134	09-02-97	1716	333.7	2,125
04-11-96	0720	319.8	2,139	11-12-96	1215	324.2	2,135	10-17-97	0640	334.4	2,125
04-11-96	1504	319.7	2,139	11-13-96	1007	324.2	2,135	11-24-97	1431	332.9	2,126
04-15-96	1755	319.5	2,140	11-13-96	1619	324.2	2,135	01-09-98	1408	329.6	2,129
04-22-96	1615	319.3	2,140	11-14-96	1055	323.9	2,135	02-20-98	0852	323.5	2,136
05-02-96	1815	319.9	2,139	11-15-96	1203	323.7	2,135	03-19-98	0754	322.3	2,137
05-06-96	0704	320.2	2,139	11-22-96	1331	322.7	2,136	03-19-98	1430	322.5	2,137
05-06-96	1232	320.3	2,139	12-10-96	1018	321.5	2,138	04-10-98	0847	321.5	2,138
05-06-96	1633	320.4	2,139	12-30-96	1121	319.9	2,139	04-29-98*	1220	320.7	2,138
05-13-96	1617	321.5	2,138	01-29-97	1228	318.3	2,141	05-27-98	0645	320.1	2,139
05-23-96	1728	324.6	2,134	02-20-97	1138	318.3	2,141	06-15-98	1239	320.9	2,138
06-04-96	0542	330.3	2,129	03-19-97	1255	320.2	2,139	06-30-98	1134	323.2	2,136
06-30-96	1736	332.6	2,126	04-14-97	0818	320.2	2,139	08-04-98	1129	332.3	2,127
07-24-96	1550	333.4	2,126	04-17-97	0649	320.5	2,139	09-03-98	1200	330.0	2,129

Table 2. Water levels in piezometers and wells measured for the injection, storage, and recovery study at Lancaster, Antelope Valley, California, September 1995 through September 1998—Continued

Measurement		Water level		Measurement		Water level		Measurement		Water level	
Date	Time	Depth	Altitude	Date	Time	Depth	Altitude	Date	Time	Depth	Altitude
7N/12W-27F1											
12-08-95	0820	310.4	2,134	05-23-96	1656	311.8	2,132	04-14-97	0916	299.9	2,144
01-24-96	1535	306.2	2,138	06-04-96	0642	315.3	2,129	04-17-97	0754	300.2	2,144
01-30-96	1210	307.7	2,136	06-30-96	1612	317.7	2,126	04-17-97	1444	300.7	2,143
04-03-96	0831	304.0	2,140	07-24-96	1510	318.6	2,125	04-22-97	0654	302.3	2,142
04-04-96	1341	303.7	2,140	08-30-96	1140	320.1	2,124	04-28-97	1004	302.7	2,141
04-08-96	0732	303.6	2,140	10-04-96	1741	319.6	2,124	05-06-97	0740	303.0	2,141
04-08-96	1404	303.4	2,141	10-18-96	0651	320.6	2,123	05-30-97	0612	309.8	2,134
04-08-96	1530	303.3	2,141	10-21-96	0708	320.7	2,123	06-19-97	0726	309.2	2,135
04-08-96	1707	303.2	2,141	10-22-96	0738	316.5	2,128	07-22-97	0828	314.7	2,129
04-09-96	0750	302.9	2,141	10-22-96	1335	316.1	2,128	09-02-97	1731	318.0	2,126
04-09-96	1618	302.8	2,141	10-31-96	0903	313.1	2,131	10-17-97	0724	320.8	2,123
04-10-96	1155	302.7	2,141	11-07-96	0852	311.3	2,133	11-24-97	1238	317.8	2,126
04-10-96	1745	302.6	2,141	11-12-96	1258	311.4	2,133	01-09-98	1520	313.6	2,130
04-11-96	0647	302.5	2,142	11-13-96	0846	310.3	2,134	02-20-98	0758	308.1	2,136
04-11-96	1635	302.4	2,142	11-13-96	1655	310.1	2,134	04-10-98	0732	304.2	2,140
04-15-96	1835	302.3	2,142	11-14-96	1136	309.8	2,134	04-29-98*	1343	303.3	2,141
04-22-96	1139	301.9	2,142	11-15-96	1010	309.5	2,135	05-27-98	1251	302.1	2,142
05-02-96	1702	303.6	2,140	11-22-96	1414	308.7	2,135	06-15-98	1139	301.9	2,142
05-06-96	0734	303.7	2,140	12-10-96	1111	306.4	2,138	06-30-98	1244	305.8	2,138
05-06-96	0916	303.8	2,140	12-30-96	1201	302.6	2,141	08-04-98	1529	318.0	2,126
05-06-96	1125	304.0	2,140	01-29-97	1319	300.0	2,144	09-03-98	1436	315.7	2,128
05-06-96	1534	304.2	2,140	02-20-97	1216	299.0	2,145				
05-13-96	1514	305.9	2,138	03-19-97	1342	300.8	2143				

Table 2. Water levels in piezometers and wells measured for the injection, storage, and recovery study at Lancaster, Antelope Valley, California, September 1995 through September 1998—Continued

Measurement		Water level		Measurement		Water level		Measurement		Water level	
Date	Time	Depth	Altitude	Date	Time	Depth	Altitude	Date	Time	Depth	Altitude
7N/12W-27F3											
03-25-96	0752	294.0	2,146	05-23-96	1138	309.9	2,130	02-20-97	1226	283.5	2,157
04-03-96	0923	293.0	2,147	05-23-96	1623	312.9	2,127	03-19-97	1352	285.2	2,155
04-04-96	1552	292.8	2,147	06-04-96	0651	321.3	2,119	04-14-97	0904	284.3	2,156
04-08-96	0725	293.4	2,147	06-30-96	1559	325.0	2,115	04-17-97	0744	284.7	2,155
04-08-96	1413	293.2	2,147	07-24-96	1455	327.3	2,113	04-17-97	1438	285.0	2,155
04-08-96	1542	293.2	2,147	08-30-96	1126	329.2	2,111	04-22-97	0643	286.7	2,153
04-08-96	1701	293.1	2,147	10-04-96	1037	326.3	2,114	04-28-97	0953	287.2	2,153
04-09-96	0739	292.8	2,147	10-18-96	0701	326.9	2,113	05-06-97	0708	290.0	2,150
04-09-96	1610	292.8	2,147	10-21-96	0746	326.6	2,113	05-30-97	0625	308.1	2,132
04-10-96	1143	292.7	2,147	10-22-96	0728	313.1	2,127	06-19-97	0907	304.8	2,135
04-10-96	1740	292.7	2,147	10-22-96	1326	312.1	2,128	09-02-97	1739	322.2	2,118
04-11-96	0640	292.3	2,148	10-31-96	0940	307.3	2,133	10-17-97	0748	325.0	2,115
04-11-96	1619	292.2	2,148	11-07-96	0814	300.3	2,140	11-24-97	1226	312.4	2,128
04-15-96	1823	291.8	2,148	11-12-96	1307	299.9	2,140	01-09-98	1723	304.6	2,135
04-22-96	1127	292.4	2,148	11-13-96	0903	298.6	2,141	02-20-98	0740	293.3	2,147
05-02-96	1710	295.8	2,144	11-13-96	1702	298.3	2,142	04-10-98	0711	286.1	2,154
05-06-96	0740	296.4	2,144	11-14-96	1143	297.8	2,142	04-29-98*	1353	285.4	2,155
05-06-96	0923	296.6	2,143	11-15-96	1000	297.4	2,143	05-27-98	1315	283.2	2,157
05-06-96	1115	296.7	2,143	11-22-96	1421	295.6	2,144	06-15-98	1127	283.4	2,157
05-06-96	1527	297.0	2,143	12-10-96	1102	291.5	2,149	06-30-98	1255	288.6	2,151
05-13-96	1504	299.9	2,140	12-30-96	1155	286.1	2,154	08-04-98	1544	324.1	2,116
05-23-96	0807	303.9	2,136	01-29-97	1332	279.4	2,161	09-03-98	0855	318.1	2,122

Table 2. Water levels in piezometers and wells measured for the injection, storage, and recovery study at Lancaster, Antelope Valley, California, September 1995 through September 1998—Continued

Measurement		Water level		Measurement		Water level		Measurement		Water level	
Date	Time	Depth	Altitude	Date	Time	Depth	Altitude	Date	Time	Depth	Altitude
7N/12W-27F5											
02-26-96	1627	289.8	2,151.8	07-24-96	1331	325.8	2,115.8	05-05-97	1657	284.6	2,157.0
03-20-96	1314	291.7	2,149.9	07-26-96	1528	325.9	2,115.7	05-06-97	1123	284.5	2,157.1
03-28-96	0842	289.8	2,151.8	08-30-96	1012	327.8	2,113.8	05-28-97	1726	317.4	2,124.2
03-29-96	0807	289.7	2,151.9	10-03-96	1203	326.5	2,115.1	05-30-97	0841	305.6	2,136.0
04-01-96	0755	290.7	2,150.9	10-18-96	1541	325.5	2,116.1	06-18-97	1105	300.7	2,140.9
04-02-96	0816	289.7	2,151.9	10-28-96	1234	304.3	2,137.3	06-20-97	0808	300.0	2,141.6
04-04-96	0815	289.5	2,152.1	10-29-96	0706	303.7	2,137.9	07-21-97	1112	321.8	2,119.8
04-08-96	0818	290.2	2,151.4	11-02-96	0931	303.0	2,138.6	09-02-97	1108	325.8	2,115.8
04-09-96	0744	290.2	2,151.4	11-09-96	1122	298.0	2,143.6	10-16-97	1123	325.3	2,116.3
04-10-96	0707	290.3	2,151.3	11-14-96	1614	295.9	2,145.7	11-24-97	0827	315.0	2,126.6
04-11-96	0937	290.2	2,151.4	11-23-96	1016	293.2	2,148.4	01-09-98	1103	303.0	2,138.6
04-15-96	1106	289.7	2,151.9	11-24-96	1222	293.0	2,148.6	02-17-98	1214	288.9	2,152.7
04-22-96	0927	290.8	2,150.8	12-09-96	1544	289.1	2,152.5	04-07-98	1306	282.6	2,159.0
04-23-96	0818	291.2	2,150.4	12-29-96	0940	284.6	2,157.0	04-28-98*	1724	281.1	2,160.5
05-02-96	1204	293.9	2,147.7	01-29-97	1702	278.8	2,162.8	05-26-98	1643	279.8	2,161.8
05-05-96	1733	294.6	2,147.0	02-20-97	1526	280.4	2,161.2	06-29-98	1742	283.7	2,157.9
05-13-96	0908	297.3	2,144.3	03-19-97	1607	281.5	2,160.1	08-03-98	1802	313.7	2,127.9
05-23-96	0855	302.9	2,138.7	04-11-97	1101	280.7	2,160.9	09-03-98	0617	314.7	2,126.9
06-03-96	1825	319.0	2,122.6	04-16-97	1521	281.2	2,160.4				
06-30-96	1043	323.5	2,118.1	05-05-97	0903	283.5	2,158.1				

Table 2. Water levels in piezometers and wells measured for the injection, storage, and recovery study at Lancaster, Antelope Valley, California, September 1995 through September 1998—Continued

Measurement		Water level		Measurement		Water level		Measurement		Water level	
Date	Time	Depth	Altitude	Date	Time	Depth	Altitude	Date	Time	Depth	Altitude
7N/12W-27F6											
02-26-96	1636	304.0	2,137.6	07-24-96	1337	338.0	2,103.6	04-16-97	1531	295.6	2,146.0
03-20-96	1324	304.8	2,136.8	07-26-96	1536	338.0	2,103.6	05-05-97	0912	303.3	2,138.3
03-28-96	0849	303.6	2,138.0	08-30-96	1021	337.8	2,103.8	05-05-97	1703	303.0	2,138.6
03-29-96	0759	303.6	2,138.0	10-03-96	1217	337.2	2,104.4	05-06-97	1126	302.9	2,138.7
04-01-96	0806	303.5	2,138.1	10-18-96	1553	339.8	2,101.8	05-29-97	0657	332.3	2,109.3
04-02-96	0826	303.4	2,138.2	10-28-96	1238	315.5	2,126.1	05-30-97	0849	322.9	2,118.7
04-04-96	0823	302.8	2,138.8	10-28-96	1319	315.5	2,126.1	06-18-97	1112	322.1	2,119.5
04-08-96	0823	303.2	2,138.4	10-29-96	0709	315.1	2,126.5	06-20-97	0815	322.7	2,118.9
04-09-96	0748	300.2	2,141.4	11-01-96	0911	314.5	2,127.1	07-21-97	1124	336.6	2,105.0
04-10-96	0715	300.2	2,141.4	11-02-96	0756	314.8	2,126.8	09-02-97	1121	341.2	2,100.4
04-11-96	0944	298.2	2,143.4	11-09-96	1135	311.4	2,130.2	10-16-97	1138	341.2	2,100.4
04-11-96	1025	298.2	2,143.4	11-14-96	1622	304.6	2,137.0	11-24-97	0842	335.1	2,106.5
04-15-96	1114	296.9	2,144.7	11-23-96	1026	302.6	2,139.0	01-09-98	1119	325.2	2,116.4
04-22-96	0935	296.7	2,144.9	11-24-96	1213	302.5	2,139.1	02-17-98	1229	307.9	2,133.7
05-02-96	1212	298.0	2,143.6	12-09-96	1554	300.9	2,140.7	04-07-98	1326	304.1	2,137.5
05-05-96	1741	298.1	2,143.5	12-29-96	0950	297.8	2,143.8	04-28-98*	1736	298.8	2,142.8
05-13-96	0916	305.7	2,135.9	01-29-97	1713	294.9	2,146.7	05-26-98	1654	297.5	2,144.1
05-23-96	0859	317.8	2,123.8	02-20-97	1546	294.9	2,146.7	06-29-98	1836	305.2	2,136.4
06-03-96	1835	336.8	2,104.8	03-19-97	1620	295.9	2,145.7	08-03-98	1810	330.9	2,110.7
06-30-96	1050	339.8	2,101.8	04-11-97	1113	295.3	2,146.3	09-03-98	0634	330.0	2,111.6

Table 2. Water levels in piezometers and wells measured for the injection, storage, and recovery study at Lancaster, Antelope Valley, California, September 1995 through September 1998—Continued

Measurement		Water level		Measurement		Water level		Measurement		Water level	
Date	Time	Depth	Altitude	Date	Time	Depth	Altitude	Date	Time	Depth	Altitude
7N/12W-27F7											
02-26-96	1647	304.6	2,137.0	07-26-96	1544	341.0	2,100.6	05-05-97	1708	306.2	2,135.4
03-28-96	0852	305.8	2,135.8	08-30-96	0954	341.8	2,099.8	05-06-97	1130	306.0	2,135.6
03-29-96	0803	303.8	2,137.8	10-03-96	1309	339.8	2,101.8	05-29-97	1039	332.8	2,108.8
04-01-96	0810	305.2	2,136.4	10-18-96	1607	340.1	2,101.5	05-30-97	0923	322.8	2,118.8
04-02-96	0837	304.9	2,136.7	10-28-96	1243	318.3	2,123.3	06-18-97	1121	319.6	2,122.0
04-04-96	0830	303.8	2,137.8	10-29-96	0717	317.8	2,123.8	06-20-97	0824	320.0	2,121.6
04-08-96	0828	303.6	2,138.0	11-02-96	1151	316.7	2,124.9	07-21-97	1135	335.9	2,105.7
04-09-96	0752	302.1	2,139.5	11-09-96	1147	312.0	2,129.6	09-02-97	1130	341.6	2,100.0
04-10-96	0723	302.1	2,139.5	11-14-96	1632	309.8	2,131.8	10-16-97	1147	342.5	2,099.1
04-11-96	0957	301.1	2,140.5	11-23-96	1046	308.3	2,133.3	11-24-97	0857	335.1	2,106.5
04-15-96	1123	300.8	2,140.8	11-24-96	1234	308.1	2,133.5	01-09-98	1128	321.7	2,119.9
04-22-96	0944	300.6	2,141.0	12-09-96	1601	305.3	2,136.3	02-17-98	1239	309.5	2,132.1
05-02-96	1218	304.6	2,137.0	12-29-96	0958	299.9	2,141.7	04-07-98	1340	301.7	2,139.9
05-05-96	1746	304.9	2,136.7	01-29-97	1722	295.7	2,145.9	04-28-98*	1749	299.4	2,142.2
05-13-96	0922	310.1	2,131.5	02-20-97	1555	296.8	2,144.8	05-26-98	1705	298.0	2,143.6
05-23-96	0906	319.0	2,122.6	03-19-97	1630	301.0	2,140.6	06-30-98	0538	307.1	2,134.5
06-03-96	1841	335.7	2,105.9	04-11-97	1122	299.6	2,142.0	08-03-98	1820	329.8	2,111.8
06-30-96	1057	340.0	2,101.6	04-16-97	1539	300.7	2,140.9	09-03-98	0647	330.1	2,111.5
07-24-96	1346	340.9	2,100.7	05-05-97	0915	306.1	2,135.5				

Table 2. Water levels in piezometers and wells measured for the injection, storage, and recovery study at Lancaster, Antelope Valley, California, September 1995 through September 1998—Continued

Measurement		Water level		Measurement		Water level		Measurement		Water level	
Date	Time	Depth	Altitude	Date	Time	Depth	Altitude	Date	Time	Depth	Altitude
7N/12W-27F8											
02-26-96	1652	304.7	2,136.9	07-26-96	1552	330.2	2,111.4	05-05-97	1716	304.6	2,137.0
03-28-96	0845	305.5	2,136.1	08-30-96	1027	331.4	2,110.2	05-06-97	1135	304.4	2,137.2
03-29-96	0956	305.5	2,136.1	10-03-96	1332	330.4	2,111.2	05-28-97	1525	327.1	2,114.5
04-01-96	0813	305.1	2,136.5	10-18-96	1621	331.3	2,110.3	05-30-97	0930	314.4	2,127.2
04-02-96	0843	304.9	2,136.7	10-28-96	1247	315.5	2,126.1	06-18-97	1127	312.4	2,129.2
04-04-96	0836	304.2	2,137.4	10-29-96	0720	315.2	2,126.4	06-20-97	0832	312.5	2,129.1
04-08-96	0836	304.0	2,137.6	11-02-96	1049	314.4	2,127.2	07-21-97	1145	331.0	2,110.6
04-09-96	0757	303.1	2,138.5	11-09-96	1056	311.4	2,130.2	09-02-97	1140	331.1	2,110.5
04-10-96	0731	303.1	2,138.5	11-14-96	1642	309.8	2,131.8	10-16-97	1258	332.5	2,109.1
04-11-96	1004	302.5	2,139.1	11-23-96	1056	308.5	2,133.1	11-24-97	0909	327.3	2,114.3
04-15-96	1128	302.4	2,139.2	11-24-96	1243	308.3	2,133.3	01-09-98	1137	315.8	2,125.8
04-22-96	0952	302.1	2,139.5	12-09-96	1612	305.8	2,135.8	02-17-98	1246	309.1	2,132.5
05-02-96	1226	304.7	2,136.9	12-29-96	1008	301.6	2,140.0	04-07-98	1352	303.4	2,138.2
05-05-96	1752	304.9	2,136.7	01-29-97	1730	299.0	2,142.6	04-28-98*	1800	301.9	2,139.7
05-13-96	0935	308.4	2,133.2	02-20-97	1604	298.2	2,143.4	05-26-98	1717	301.1	2,140.5
05-23-96	0911	313.3	2,128.3	03-19-97	1638	301.0	2,140.6	06-30-98	0632	306.7	2,134.9
06-03-96	1846	325.8	2,115.8	04-11-97	1132	299.8	2,141.8	08-03-98	1834	323.3	2,118.3
06-30-96	1102	329.3	2,112.3	04-16-97	1550	300.6	2,141.0	09-03-98	0701	324.4	2,117.2
07-24-96	1351	330.1	2,111.5	05-05-97	0920	305.2	2,136.4				

Table 2. Water levels in piezometers and wells measured for the injection, storage, and recovery study at Lancaster, Antelope Valley, California, September 1995 through September 1998—Continued

Measurement		Water level		Measurement		Water level		Measurement		Water level	
Date	Time	Depth	Altitude	Date	Time	Depth	Altitude	Date	Time	Depth	Altitude
7N/12W-27H1											
04-03-96	1044	310.9	2,138	06-30-96	1620	325.5	2,124	04-17-97	0724	306.2	2,143
04-04-96	1332	310.8	2,138	07-24-96	1520	326.9	2,122	04-17-97	1451	306.6	2,142
04-08-96	0843	310.6	2,138	08-30-96	1150	327.2	2,122	04-22-97	0710	307.9	2,141
04-08-96	1422	310.5	2,139	10-04-96	1728	327.4	2,122	04-28-97	1015	308.2	2,141
04-08-96	1552	310.4	2,139	10-18-96	0717	328.9	2,120	05-06-97	0751	308.6	2,140
04-08-96	1717	310.3	2,139	10-21-96	0743	328.7	2,120	05-30-97	0603	320.4	2,129
04-09-96	1032	310.0	2,139	10-22-96	0754	324.6	2,124	06-19-97	0735	320.3	2,129
04-09-96	1643	310.0	2,139	10-22-96	1348	324.2	2,125	07-22-97	0842	322.0	2,127
04-10-96	1209	309.9	2,139	10-30-96	1131	320.8	2,128	09-02-97	1629	326.3	2,123
04-10-96	1730	309.8	2,139	11-07-96	0907	318.8	2,130	10-17-97	0714	329.9	2,119
04-11-96	0858	309.7	2,139	11-12-96	1245	318.6	2,130	11-24-97	1248	329.4	2,120
04-11-96	1529	309.6	2,139	11-13-96	0921	317.7	2,131	01-09-98	1507	326.2	2,123
04-15-96	1652	309.3	2,140	11-13-96	1646	317.6	2,131	02-20-98	0812	316.7	2,132
04-22-96	1600	308.8	2,140	11-14-96	1126	317.3	2,132	03-18-98	1800	315.3	2,134
05-02-96	1724	309.5	2,140	11-15-96	0940	317.1	2,132	04-10-98	0742	312.5	2,137
05-06-96	0754	309.5	2,140	11-22-96	1358	316.0	2,133	04-29-98*	1331	311.2	2,138
05-06-96	0904	309.6	2,139	12-10-96	1052	313.7	2,135	05-27-98	1303	309.8	2,139
05-06-96	1137	309.7	2,139	12-30-96	1140	310.3	2,139	06-15-98	1152	309.3	2,140
05-06-96	1602	309.8	2,139	01-29-97	1307	307.3	2,142	06-30-98	1230	312.0	2,137
05-13-96	1542	312.2	2,137	02-20-97	1205	306.2	2,143	08-04-98	1516	324.2	2,125
05-23-96	1715	319.4	2,130	03-19-97	1327	307.2	2,142	09-03-98	1423	322.7	2,126
06-04-96	0632	322.8	2,126	04-14-97	0853	306.0	2,143				

Table 2. Water levels in piezometers and wells measured for the injection, storage, and recovery study at Lancaster, Antelope Valley, California, September 1995 through September 1998—Continued

Measurement		Water level		Measurement		Water level		Measurement		Water level	
Date	Time	Depth	Altitude	Date	Time	Depth	Altitude	Date	Time	Depth	Altitude
7N/12W-27H5											
03-19-96	1026	315.3	2,134	06-30-96	1701	384.6	2,064	05-05-97	1118	297.5	2,152
03-19-96	1531	314.3	2,135	07-24-96	1611	385.2	2,064	05-06-97	1047	298.5	2,151
03-20-96	0853	311.5	2,138	08-30-96	1258	384.3	2,065	05-29-97	1515	370.5	2,079
03-21-96	1057	321.3	2,128	10-04-96	1634	384.2	2,065	06-18-97	0945	348.8	2,100
03-22-96	1131	308.5	2,141	10-18-96	0924	369.7	2,079	07-22-97	0646	357.6	2,091
03-26-96	1349	305.2	2,144	10-21-96	0815	368.2	2,081	09-02-97	1643	380.1	2,069
03-29-96	1139	303.4	2,146	10-21-96	0832	369.6	2,079	10-17-97	0613	390.4	2,059
04-02-96	1107	302.4	2,147	10-22-96	0834	345.0	2,104	11-24-97	1410	379.6	2,069
04-03-96	0825	302.2	2,147	10-22-96	1418	342.9	2,106	01-09-98	1349	368.9	2,080
04-04-96	1017	302.0	2,147	10-30-96	1205	322.7	2,126	02-20-98	0925	305.9	2,143
04-08-96	0857	301.5	2,148	11-06-96	1526	316.9	2,132	03-19-98	0649	308.2	2,141
04-09-96	1337	301.0	2,148	11-09-96	1445	314.9	2,134	03-19-98	1600	306.7	2,142
04-10-96	0912	300.8	2,148	11-15-96	0805	311.8	2,137	04-10-98	0826	299.1	2,150
04-11-96	1314	300.6	2,148	11-24-96	1459	308.5	2,141	04-29-98*	1249	296.0	2,153
04-15-96	1407	299.8	2,149	12-09-96	1117	304.7	2,144	05-27-98	0738	293.2	2,156
04-23-96	0514	299.6	2,149	12-29-96	1803	299.8	2,149	06-15-98	1222	292.9	2,156
05-02-96	1446	301.3	2,148	01-30-97	0747	294.7	2,154	06-30-98	1200	297.0	2,152
05-05-96	1322	301.7	2,147	02-21-97	0818	294.5	2,155	08-04-98	1156	362.4	2,087
05-13-96	1107	306.3	2,143	03-20-97	0602	295.4	2,154	09-03-98	1235	331.0	2,118
05-23-96	1332	356.9	2,092	04-11-97	1412	294.4	2,155				
06-04-96	0502	382.1	2,067	04-16-97	1734	294.7	2,154				

Table 2. Water levels in piezometers and wells measured for the injection, storage, and recovery study at Lancaster, Antelope Valley, California, September 1995 through September 1998—Continued

Measurement		Water level		Measurement		Water level		Measurement		Water level	
Date	Time	Depth	Altitude	Date	Time	Depth	Altitude	Date	Time	Depth	Altitude
7N/12W-27H7											
03-19-96	1041	313.0	2,136	06-04-96	0516	368.1	2,081	04-16-97	1750	302.1	2,147
03-19-96	1554	313.9	2,135	06-30-96	1717	376.1	2,073	05-05-97	1127	307.4	2,142
03-20-96	0843	315.2	2,134	07-24-96	1622	374.3	2,075	05-06-97	1051	308.6	2,140
03-21-96	1114	316.8	2,132	08-30-96	1312	368.6	2,080	05-29-97	1529	353.4	2,096
03-22-96	1149	314.7	2,134	10-04-96	1645	367.6	2,081	06-18-97	1006	349.5	2,100
03-26-96	1405	312.4	2,137	10-18-96	0940	368.3	2,081	07-22-97	0703	348.2	2,101
03-29-96	1234	311.0	2,138	10-21-96	0810	368.0	2,081	09-02-97	1655	364.8	2,084
04-02-96	1118	310.3	2,139	10-22-96	0945	337.7	2,111	10-17-97	0626	372.7	2,076
04-03-96	0842	310.1	2,139	10-22-96	1430	333.7	2,115	11-24-97	1416	367.3	2,082
04-04-96	1042	309.8	2,139	10-30-96	1214	321.5	2,128	01-09-98	1356	359.3	2,090
04-08-96	0926	309.3	2,140	11-06-96	1512	318.7	2,130	02-20-98	0940	314.3	2,135
04-09-96	1409	308.6	2,140	11-09-96	1509	316.8	2,132	03-19-98	0734	314.0	2,135
04-10-96	0921	307.9	2,141	11-15-96	0822	312.2	2,137	03-19-98	1613	313.5	2,136
04-11-96	1323	307.1	2,142	11-24-96	1514	310.2	2,139	04-10-98	0832	309.4	2,140
04-15-96	1419	305.0	2,144	12-09-96	1131	308.3	2,141	04-29-98*	1258	305.8	2,143
04-23-96	0541	303.9	2,145	12-29-96	1825	304.6	2,144	05-27-98	0756	303.4	2,146
05-02-96	1457	304.2	2,145	01-30-97	0811	301.6	2,147	06-15-98	1226	303.3	2,146
05-05-96	1307	304.3	2,145	02-21-97	0837	301.4	2,148	06-30-98	1205	310.3	2,139
05-13-96	1118	307.9	2,141	03-20-97	0625	302.9	2,146	08-04-98	1202	351.4	2,098
05-23-96	1343	344.5	2,105	04-11-97	1434	301.8	2,147	09-03-98	1240	343.3	2,106

Table 2. Water levels in piezometers and wells measured for the injection, storage, and recovery study at Lancaster, Antelope Valley, California, September 1995 through September 1998—Continued

Measurement		Water level		Measurement		Water level		Measurement		Water level	
Date	Time	Depth	Altitude	Date	Time	Depth	Altitude	Date	Time	Depth	Altitude
7N/12W-27J5											
03-19-96	1112	318.9	2,130	07-24-96	1602	343.3	2,106	05-29-97	1354	335.6	2,113
03-28-96	1034	308.2	2,141	08-30-96	1249	339.4	2,110	06-18-97	0935	327.9	2,121
03-28-96	1114	308.2	2,141	10-04-96	1655	339.0	2,110	07-22-97	0724	332.5	2,117
03-29-96	1326	308.2	2,141	10-18-96	0947	338.3	2,111	09-02-97	1703	338.1	2,111
04-02-96	1157	307.7	2,141	10-21-96	0823	340.1	2,109	10-17-97	0600	344.6	2,104
04-03-96	1504	307.4	2,142	10-22-96	0855	323.8	2,125	11-24-97	1401	340.6	2,108
04-04-96	1116	307.4	2,142	10-22-96	1440	322.9	2,126	01-09-98	1341	335.4	2,114
04-08-96	0956	307.1	2,142	10-31-96	1206	317.0	2,132	02-20-98	0910	312.5	2,137
04-09-96	1254	306.3	2,143	11-09-96	1413	314.4	2,135	03-19-98	0626	311.2	2,138
04-10-96	0957	306.2	2,143	11-15-96	0901	312.6	2,136	03-19-98	1550	310.9	2,138
04-11-96	1431	305.8	2,143	11-24-96	1407	311.7	2,137	04-10-98	0811	308.3	2,141
04-15-96	1539	305.1	2,144	12-09-96	1034	309.7	2,139	04-29-98*	1239	306.8	2,142
04-23-96	0649	304.9	2,144	12-29-96	1714	306.5	2,143	05-27-98	0713	305.2	2,144
05-02-96	1541	306.3	2,143	01-28-97	0902	303.7	2,145	06-15-98	1211	305.1	2,144
05-05-96	0857	306.2	2,143	02-21-97	0910	303.2	2,146	06-30-98	1150	309.0	2,140
05-13-96	1219	309.4	2,140	03-20-97	0721	304.4	2,145	08-04-98	1146	336.7	2,112
05-23-96	1249	339.5	2,110	04-11-97	1519	303.3	2,146	09-03-98	1224	326.3	2,123
06-04-96	0524	345.9	2,103	05-05-97	1222	307.6	2,141				
06-30-96	1650	345.3	2,104	05-06-97	1025	306.2	2,143				

Table 2. Water levels in piezometers and wells measured for the injection, storage, and recovery study at Lancaster, Antelope Valley, California, September 1995 through September 1998—Continued

Measurement		Water level		Measurement		Water level		Measurement		Water level	
Date	Time	Depth	Altitude	Date	Time	Depth	Altitude	Date	Time	Depth	Altitude
7N/12W-27P2											
04-02-96	0922	329.4	2,134	04-15-96	1812	252.1	2,211	11-14-96	1415	294.5	2,169
04-08-96	1318	252.1	2,211	04-22-96	1202	251.5	2,212	11-22-96	0938	281.9	2,181
04-08-96	1450	252.1	2,211	05-02-96	1735	251.2	2,212	12-10-96	1158	275.5	2,188
04-08-96	1618	252.1	2,211	05-06-96	0625	249.2	2,214	12-30-96	0824	265.5	2,198
04-08-96	1751	252.0	2,211	05-06-96	0823	308.0	2,155	01-29-97	0815	256.5	2,207
04-09-96	0814	252.1	2,211	05-06-96	0940	310.4	2,153	02-20-97	1341	252.8	2,210
04-09-96	1600	252.2	2,211	05-06-96	1206	312.7	2,150	03-19-97	1048	246.3	2,217
04-10-96	1308	252.0	2,211	05-06-96	1739	315.3	2,148	04-14-97	1053	238.7	2,224
04-10-96	1715	252.0	2,211	11-12-96	0920	337.3	2,126	04-17-97	1323	308.1	2,155
04-11-96	0808	252.1	2,211	11-13-96	0752	294.8	2,168				
7N/12W-27P3											
04-02-96	0933	329.5	2,133	04-22-96	1216	220.9	2,241	01-29-97	0856	256.5	2,206
04-08-96	1330	259.9	2,202	05-02-96	1750	197.7	2,264	02-20-97	1311	252.1	2,210
04-08-96	1500	258.2	2,204	05-06-96	0634	186.6	2,275	03-19-97	1008	242.9	2,219
04-08-96	1628	257.9	2,204	05-06-96	0837	304.5	2,158	04-14-97	0944	236.0	2,226
04-08-96	1758	255.4	2,207	05-06-96	0950	305.1	2,157	04-17-97	0825	236.1	2,226
04-09-96	0826	246.7	2,215	05-06-96	1149	307.3	2,155	04-17-97	1251	302.6	2,159
04-09-96	1547	272.6	2,189	05-06-96	1729	315.9	2,146	04-22-97	0738	317.8	2,144
04-10-96	1318	243.1	2,219	05-13-96	1643	324.3	2,138	04-22-97	0739	317.9	2,144
04-10-96	1721	241.3	2,221	11-12-96	0803	337.3	2,125	04-28-97	0930	320.8	2,141
04-11-96	0815	237.3	2,225	11-22-96	1038	285.3	2,177	05-06-97	0653	323.0	2,139
04-11-96	1537	236.8	2,225	12-10-96	1130	276.7	2,185				
04-15-96	1806	227.7	2,234	12-30-96	0735	269.2	2,193				

Table 2. Water levels in piezometers and wells measured for the injection, storage, and recovery study at Lancaster, Antelope Valley, California, September 1995 through September 1998—Continued

Measurement		Water level		Measurement		Water level		Measurement		Water level	
Date	Time	Depth	Altitude	Date	Time	Depth	Altitude	Date	Time	Depth	Altitude
7N/12W-27P5											
03-20-98	1526	304.4	2,158.3	04-29-98*	0851	300.4	2,162.3	08-03-98	0637	328.7	2,134.0
04-09-98	1214	301.8	2,160.9	05-27-98	1155	299.4	2,163.3	09-02-98	0654	329.5	2,133.2
04-10-98	1318	301.9	2,160.8	06-15-98	0837	299.9	2,162.8				
04-13-98	0829	301.5	2,161.2	06-29-98	1015	302.3	2,160.4				
7N/12W-27P6											
03-20-98	1538	332.0	2,130.7	04-29-98*	0906	325.1	2,137.6	08-03-98	0704	351.2	2,111.5
04-09-98	1601	330.1	2,132.6	05-27-98	1207	295.8	2,166.9	09-02-98	0706	350.2	2,112.5
04-10-98	1338	331.6	2,131.1	06-15-98	0844	294.6	2,168.1				
04-13-98	0841	329.8	2,132.9	06-29-98	1026	330.0	2,132.7				
7N/12W-27P7											
03-20-98	1549	332.0	2,130.7	04-13-98	0903	330.0	2,132.7	06-29-98	1033	330.3	2,132.4
04-09-98	0634	330.3	2,132.4	05-27-98	1213	305.0	2,157.7	08-03-98	0713	346.6	2,116.1
04-10-98	1402	331.2	2,131.5	06-15-98	0850	303.7	2,159.0	09-02-98	0722	347.2	2,115.5
7N/12W-27P8											
03-20-98	1600	332.5	2,130.2	04-29-98*	0925	328.4	2,134.3	08-03-98	0719	335.4	2,127.3
04-08-98	0729	330.8	2,131.9	05-27-98	1225	306.4	2,156.3	09-02-98	0734	336.4	2,126.3
04-10-98	1416	331.5	2,131.2	06-15-98	0856	305.0	2,157.7				
04-13-98	0913	330.5	2,132.2	06-29-98	1051	327.4	2,135.3				

Table 2. Water levels in piezometers and wells measured for the injection, storage, and recovery study at Lancaster, Antelope Valley, California, September 1995 through September 1998—Continued

Measurement		Water level		Measurement		Water level		Measurement		Water level	
Date	Time	Depth	Altitude	Date	Time	Depth	Altitude	Date	Time	Depth	Altitude
7N/12W-33R3											
10-21-96	1603	398.8	2,120	12-10-96	0933	389.8	2,129	11-24-97	1333	396.8	2,122
10-22-96	1000	396.3	2,123	12-30-96	1039	388.4	2,131	01-09-98	1538	395.0	2,124
10-22-96	1540	395.8	2,123	01-29-97	1145	387.7	2,131	02-20-98	1333	391.4	2,128
10-31-96	1614	398.6	2,120	02-20-97	1105	386.6	2,132	04-10-98	1045	389.5	2,130
11-07-96	1531	393.5	2,126	04-14-97	0639	385.5	2,134	04-29-98*	1059	389.6	2,129
11-12-96	1141	392.6	2,126	04-17-97	0606	386.4	2,133	05-27-98	1524	387.9	2,131
11-13-96	1047	392.1	2,127	05-30-97	0435	392.1	2,127	06-15-98	1331	387.8	2,131
11-13-96	1546	391.9	2,127	06-19-97	0447	401.2	2,118	06-30-98	1314	389.6	2,129
11-14-96	1023	391.5	2,128	07-22-97	0502	401.5	2,118	08-04-98	1339	403.7	2,115
11-15-96	1135	391.2	2,128	09-02-97	1422	400.0	2,119	09-03-98	1352	394.8	2,124
11-22-96	1254	391.2	2,128	10-16-97	1423	398.2	2,121				

Table 2. Water levels in piezometers and wells measured for the injection, storage, and recovery study at Lancaster, Antelope Valley, California, September 1995 through September 1998—Continued

Measurement		Water level		Measurement		Water level		Measurement		Water level	
Date	Time	Depth	Altitude	Date	Time	Depth	Altitude	Date	Time	Depth	Altitude
7N/12W-34B1											
03-25-96	0924	343.8	2,131	06-04-96	0559	359.4	2,116	04-10-97	1542	334.0	2,141
04-03-96	0945	343.0	2,132	06-30-96	1635	361.8	2,113	04-14-97	0802	334.3	2,141
04-04-96	1400	342.7	2,132	07-24-96	1537	360.8	2,114	04-17-97	0637	334.4	2,141
04-08-96	0828	342.6	2,132	08-30-96	1209	362.9	2,112	04-17-97	1535	336.4	2,139
04-08-96	1353	342.1	2,133	10-04-96	1716	363.2	2,112	04-22-97	0840	338.6	2,136
04-08-96	1515	341.6	2,133	10-18-96	0908	363.8	2,111	04-28-97	0855	339.1	2,136
04-08-96	1742	340.9	2,134	10-21-96	0731	363.7	2,111	05-06-97	0838	339.5	2,136
04-09-96	0943	340.0	2,135	10-22-96	0933	357.8	2,117	05-30-97	0533	356.1	2,119
04-09-96	1702	339.9	2,135	10-22-96	1513	357.2	2,118	06-19-97	0655	356.8	2,118
04-10-96	1254	340.1	2,135	10-31-96	1259	353.4	2,122	07-22-97	0526	360.0	2,115
04-10-96	1706	339.8	2,135	11-07-96	1019	351.9	2,123	09-02-97	1459	364.5	2,111
04-11-96	0757	339.6	2,135	11-07-96	1503	351.8	2,123	10-17-97	0658	367.0	2,108
04-11-96	1543	339.3	2,136	11-12-96	1202	351.4	2,124	11-24-97	1303	366.5	2,109
04-15-96	1726	338.3	2,137	11-13-96	1027	346.5	2,129	01-09-98	1658	363.8	2,111
04-22-96	1542	337.8	2,137	11-13-96	1604	346.2	2,129	02-20-98	0834	349.9	2,125
05-02-96	0937	338.8	2,136	11-14-96	1042	345.6	2,129	04-10-98	0652	345.7	2,129
05-02-96	1803	338.6	2,136	11-15-96	1200	345.2	2,130	04-29-98*	1159	343.7	2,131
05-06-96	0724	338.2	2,137	11-22-96	1317	343.9	2,131	05-27-98	0622	340.7	2,134
05-06-96	0853	338.4	2,137	12-10-96	1001	341.8	2,133	06-15-98	1304	340.3	2,135
05-06-96	1218	339.6	2,135	12-30-96	1104	338.5	2,137	06-30-98	1121	344.2	2,131
05-06-96	1716	340.5	2,135	01-29-97	1211	335.9	2,139	08-04-98	1106	353.8	2,121
05-13-96	1632	343.0	2,132	02-20-97	1126	334.6	2,140	09-03-98	1112	354.1	2,121
05-23-96	1741	355.6	2,119	03-19-97	1239	335.2	2,140				

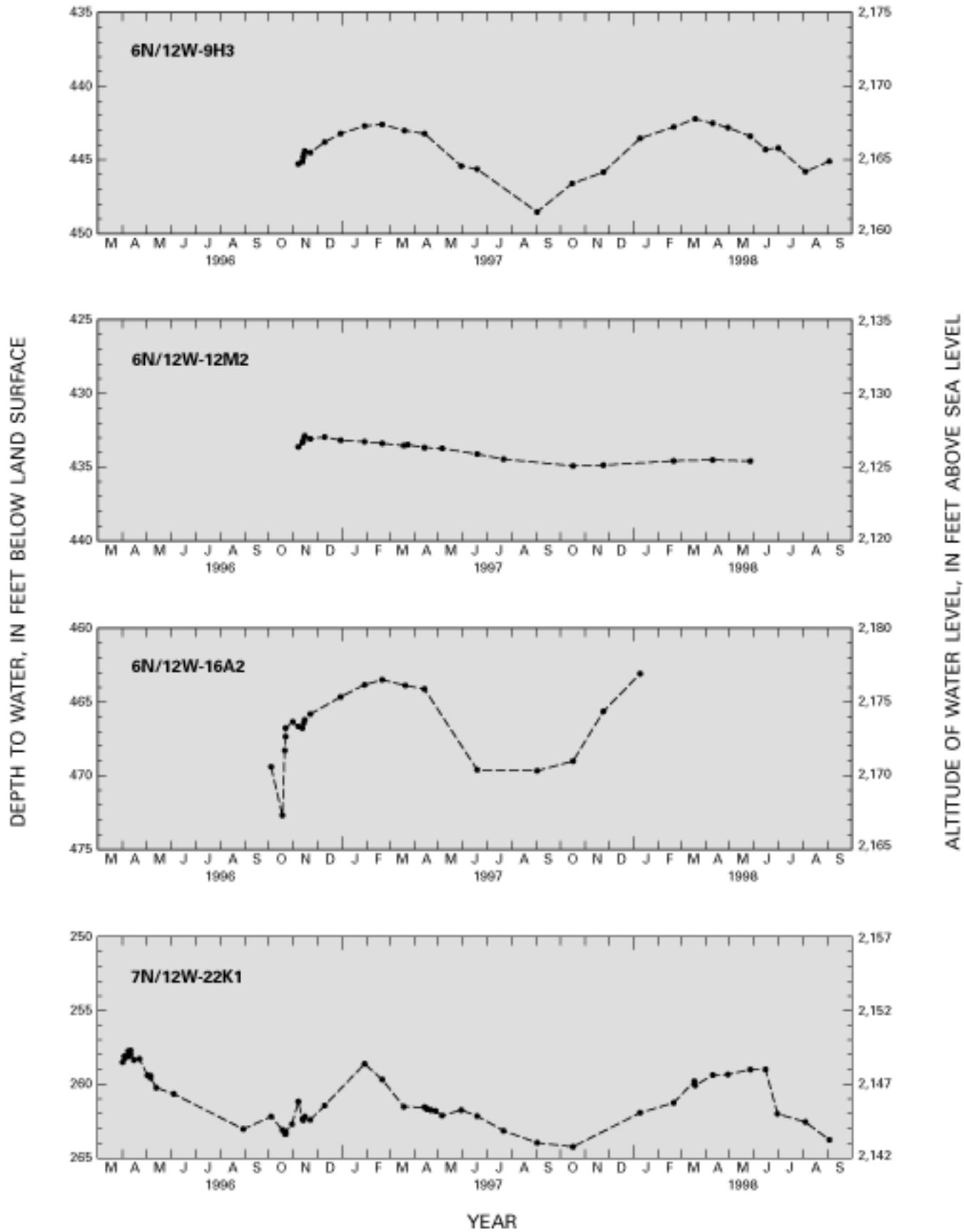


Figure 19. Periodic water levels in wells and piezometers for the injection, storage, and recovery study at Lancaster, Antelope Valley, California, March 1996 through September 1998.

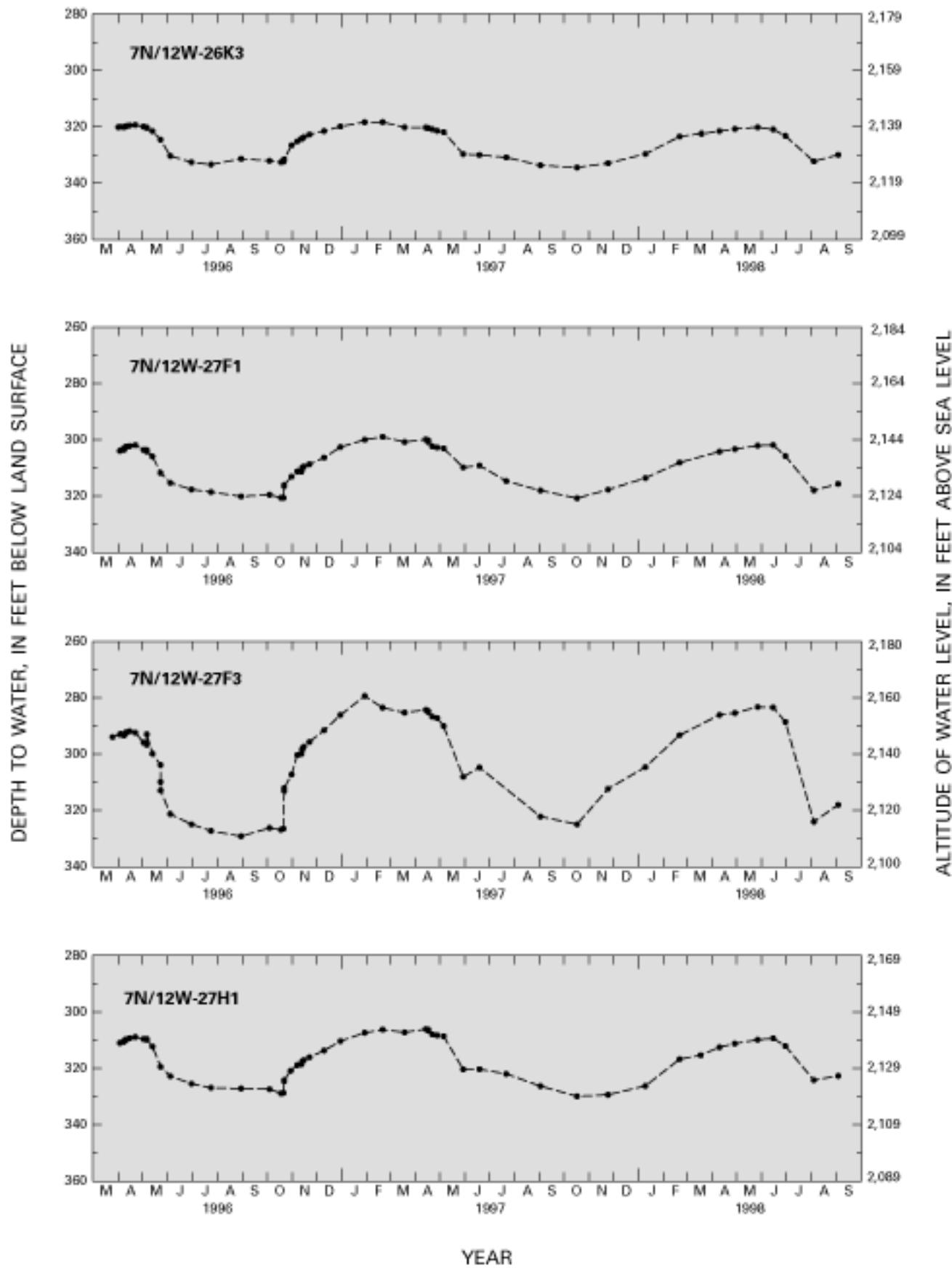


Figure 19.—Continued.

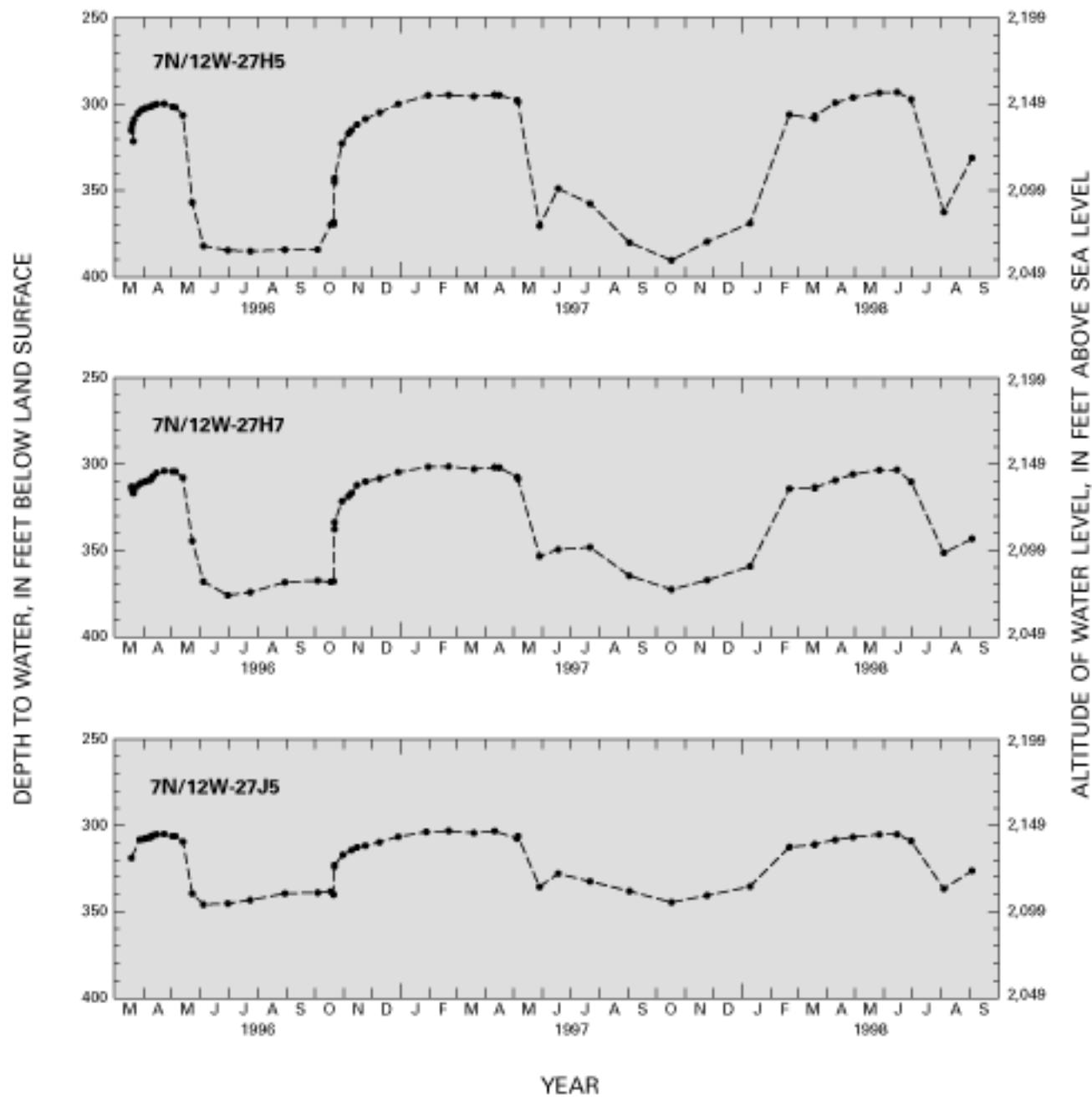


Figure 19.—Continued.

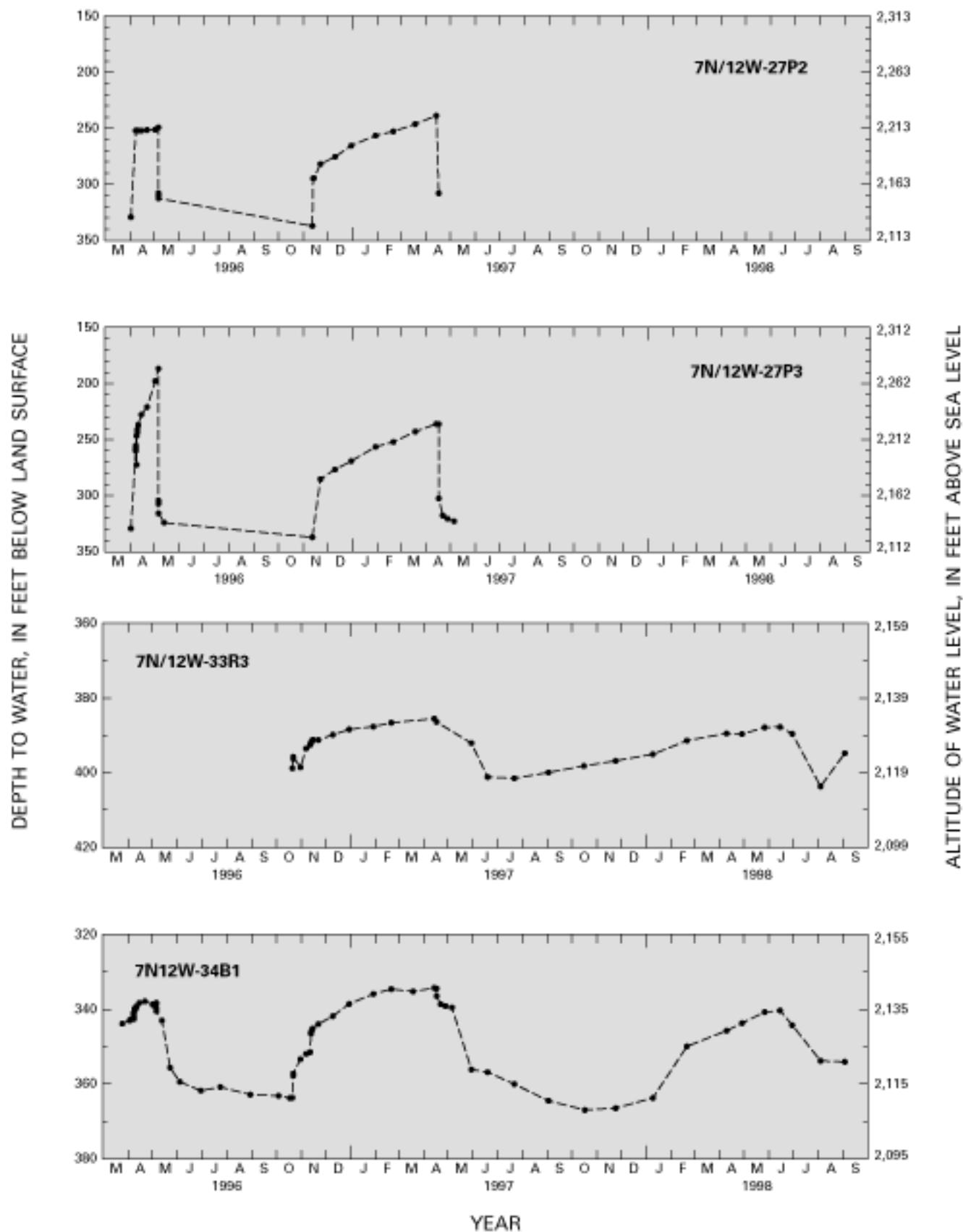


Figure 19.—Continued.

MICROGRAVITY SURVEYS

Temporal microgravity data were collected from a gravity-station monitoring network during the cycle 2 and cycle 3 injection phases. The data were used to estimate the three-dimensional shape of ground-water mounding near the injection site. The microgravity surveys were done as an alternative to installing many additional monitoring wells for measuring ground-water levels.

The gravity-station network consisted of 37 permanent gravity stations within 1 mi of the injection site (fig. 20). The gravity stations were areally distributed to measure the anticipated three-dimensional shape of ground-water mounding around the injection wells. Stations were placed in closely spaced arrays of four orthogonal spurs around the injection wells to define the slope of the ground-water mound. The first and second stations in each array were spaced 50 ft apart, the third station was spaced about 100 ft from the second, and the fourth station was spaced about 200 ft from the third. Additional stations were established at greater distances from the injection site where access permitted.

Gravity Station Construction

The gravity stations for the monitoring network were constructed to provide stable surfaces for use in future repeat surveys. Stations were constructed by auguring a 15-inch diameter hole approximately 3 ft deep. Three pieces of steel rebar 5/8 inch in diameter and 3 ft long were driven into the sides of the hole at 120-degree intervals to provide lateral stability to the native material (fig. 21). The hole was backfilled with 3.7 cubic feet (ft^3) of concrete in a continuous pour. Near the end of the pour, a 12-inch diameter cardboard tube was pushed into the concrete until it contacted the rebars. The remainder of the cardboard tube was filled with concrete so that the final top surface was about 1 inch above land surface. Approximately 15 minutes after the concrete was poured, three 2-inch diameter bronze tablets were placed into the top of the wet concrete using a template of the gravity meter legs. Bronze tablets were used because of their low coefficient of thermal expansion. One of the three bronze tablets was stamped with the station identifier (a short alpha-numeric designation) and with a central divot to accommodate the reference leg of the gravity meter. This reference leg tablet was placed in the northwest quadrant of all stations. The other two tablets were positioned so that the two cross-level legs (the two legs closest together) were oriented true north. Orienting the two cross-level legs true north eliminated

the possibility of a regional magnetic field differentially affecting the nulling device of the gravity meter. After the concrete dried, divots were drilled into the other two tablets using the template of the gravity meter legs.

The Quartz Hill bedrock reference station (fig. 3) was constructed using an existing USGS bench mark installed on Quartz Hill in 1989. The central divot in the bench mark was used as the reference leg position. The remaining two leg rests, aligned true north, were constructed by star drilling 1/2-inch holes into the crystalline rock. The holes were filled with lead and a concave head tack was hammered into the lead.

Gravity Data Collection

Gravity was measured relative to the Quartz Hill reference station (QTZ) about 3.6 mi west-southwest of the injection site. QTZ is on crystalline bedrock and was far enough from the injection site so that mass changes from injected water would not affect gravity. A secondary reference station (GR) was established near the injection site to reduce travel time between QTZ and the gravity stations. GR is approximately 500 ft east of well 7N/12W-27H1, which allowed gravity changes to be correlated with water-level changes. Mass changes from injected water were expected to be minimal because GR was hydraulically upgradient of the injection site (James Howle, U.S. Geological Survey, written commun., 2000).

A LaCoste and Romberg (L and R) Model D gravity meter (serial number D79) was used for this study. The gravity meter is equipped with an electrostatic nulling device (fig. 22) to obtain microGal accuracies. An electronic data logger read filtered output voltage from the electrostatic nulling device at 3-second intervals. The mean output voltage (for 20 measurements) and standard deviation were recorded at 1-minute intervals. Barometric pressure, measured by an electronic barometer, also was recorded at 1-minute intervals. Detailed descriptions of the pre-survey checks, the process of making gravity measurements, and the sources of survey error are provided in appendixes A, B, and C, respectively.

Three surveys (prior to injection, midway through injection, and near the end of injection) were made during cycle 2, and two surveys (prior to injection and near the end of injection) were made during cycle 3 (tables 3 and 4). All five surveys were completed using three sequential steps. During the first step, the difference in gravity between the QTZ reference station and the GR reference station near the injection site was determined. During the second step, gravity was measured for groups of three or four stations at a time

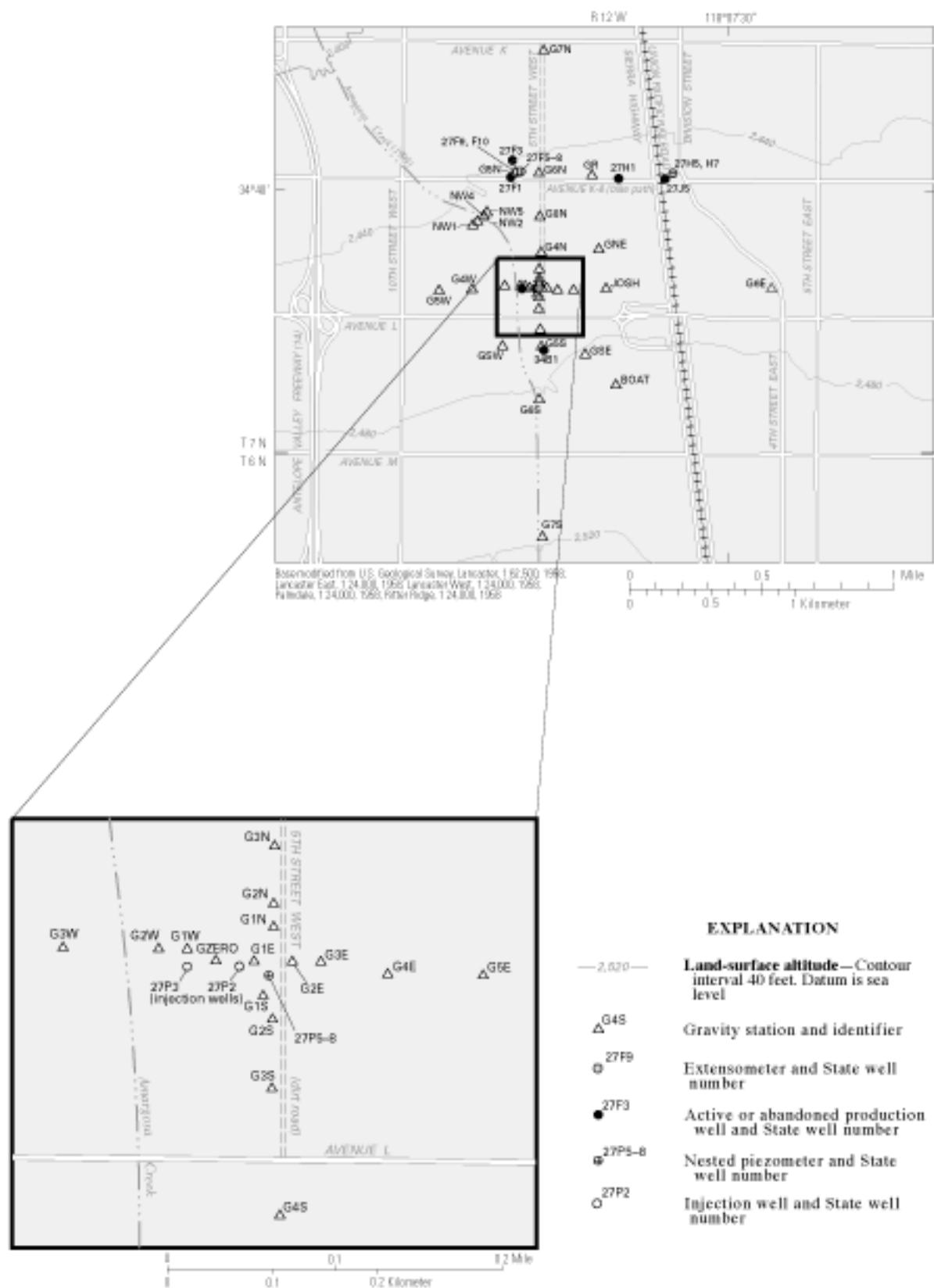


Figure 20. Locations of gravity stations used for the injection, storage, and recovery study at Lancaster, Antelope Valley, California.

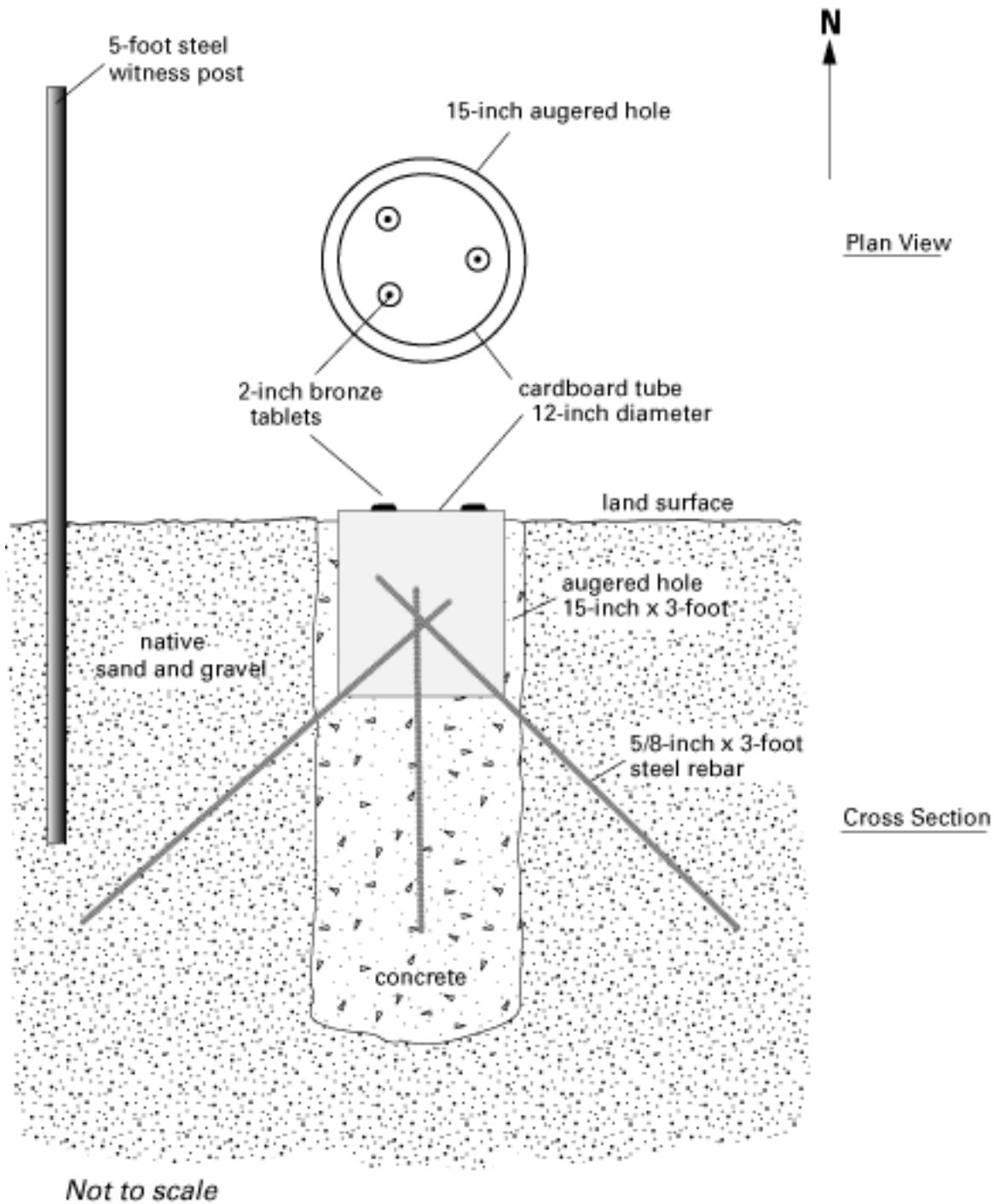


Figure 21. Gravity station construction.

in a closed loop configuration that began and ended at the GR reference station. Each station loop was completed twice resulting in two gravity measurements for each gravity station and three gravity measurements for the GR reference station. Multiple gravity measurements were made at each station to evaluate instrument drift during the survey and to assess the repeatability and accuracy of the measured differences in gravity. During the third step, the total difference in gravity between the stable bedrock and the gravity stations was calculated by adding the difference in gravity between the QTZ and GR reference stations to

the difference between the GR reference station and any other station.

The gravity stations were interspersed among the second-order vertical-control bench marks established for this study to monitor possible land-surface elevation changes (see “Geodetic Monitoring” section). The gravity stations and vertical-control bench marks were leveled simultaneously during each differential-leveling survey. It was critical to have vertical control during the injection period to ensure that any changes in gravity were caused by changes in aquifer mass and not by changes in station altitude owing to aquifer-system deformation.

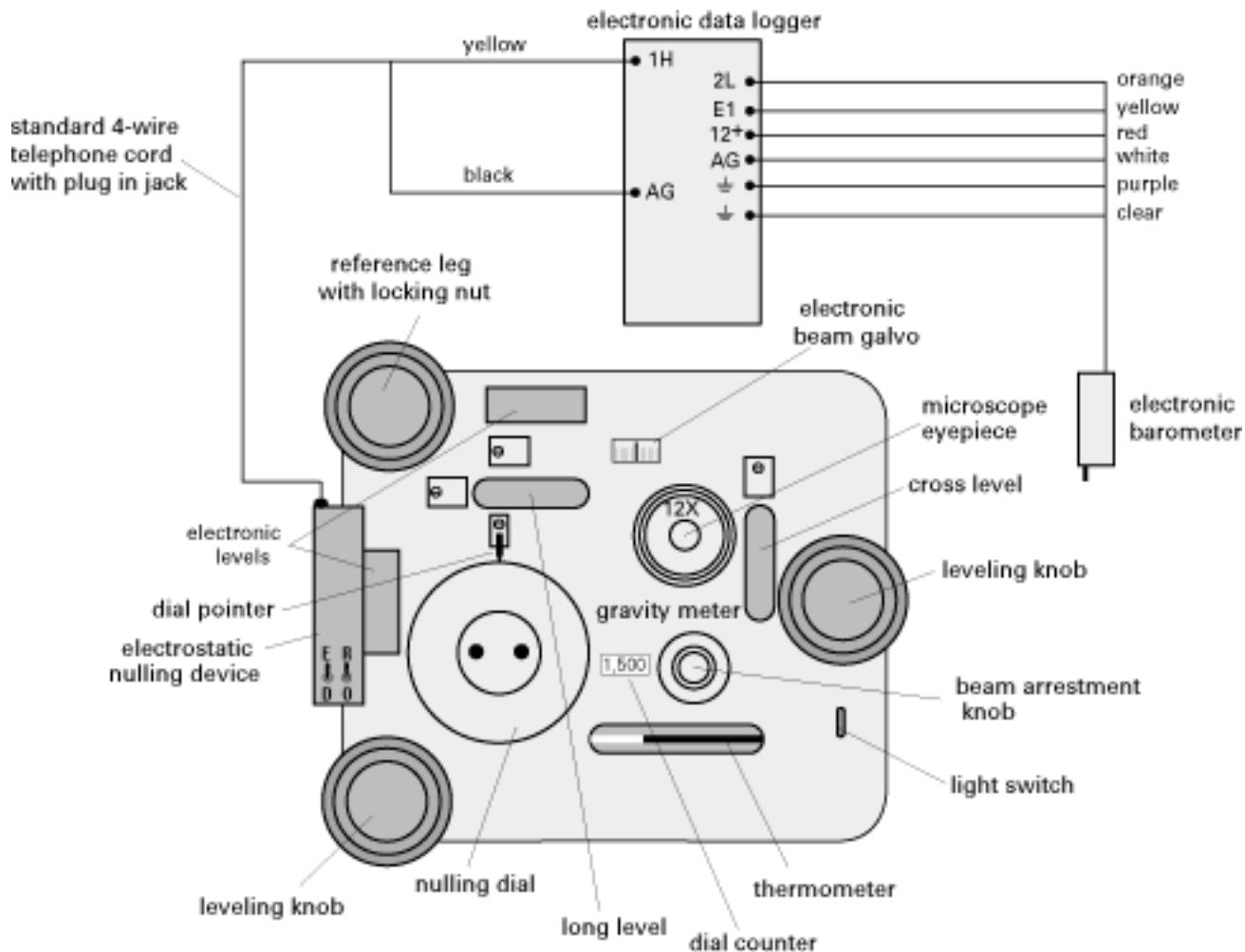


Figure 22. Top view of a LaCoste and Romberg Model D gravity meter and schematic wiring diagram of an electronic data logger and barometer.

Table 3. Microgravity data collected during cycle 2 of the injection, storage, and recovery study at Lancaster, Antelope Valley, California, November 1996 through April 1997

[Latitude and longitude are referenced to the North American Datum of 1983 (NAD83), determined using GPS in 1996–97. Gravity measured relative to Quartz Hill bedrock reference station 3.6 miles from injection site (fig. 3). Station altitudes are referenced to the National Geodetic Vertical Datum of 1929 (NGVD29) and were measured by leveling to second-order standards of accuracy. Altitudes for the pre-injection survey were measured during November 4–13, 1996, and for the near-completion of injection on April 9, 1997, unless indicated otherwise (see footnotes). mGal, milliGal; μGal , microGal; mm, millimeter. \bar{x} , mean. —, no data]

Gravity station identifier (fig. 20)	Latitude	Longitude	Pre-injection survey (November 5–9, 1996)				Mid-injection survey (January 29–February 1, 1997)		Change in microgravity from previous survey (μGal)
			Mean change in microgravity (mGal)	Standard deviation (μGal)	Station altitude		Mean change in microgravity (mGal)	Standard deviation (μGal)	
			feet	meters					
G5N ¹	34°40'05"	118°08'26"	-4.774	7.3	2,441.606	744.2014	-4.770	1.0	+4
G3N	34°39'47"	118°08'20"	-4.684	9.0	2,459.698	749.7158	-4.659	9.3	+25
G2N	34°39'45"	118°08'20"	-4.633	1.5	2,461.429	750.2436	-4.606	2.6	+27
G1N	34°39'44"	118°08'20"	-4.611	4.5	2,462.123	750.4551	-4.580	2.6	+31
GR	34°40'05"	118°08'09"	-6.098	5.3	2,445.648	745.4336	-6.097	1.8	+1
G4W	34°39'43"	118°08'36"	-2.609	4.6	2,454.687	² 748.1885	-2.577	6.5	+32
G3W	34°39'43"	118°08'28"	-3.648	4.3	2,459.406	749.6268	-3.610	5.0	+38
G2W	34°39'43"	118°08'25"	-4.014	4.5	2,460.469	749.9511	-3.980	2.1	+34
G1W	34°39'43"	118°08'24"	-4.196	1.4	2,461.487	750.2612	-4.162	7.5	+34
GZERO	34°39'43"	118°08'22"	-4.298	3.8	2,461.622	750.3025	-4.266	3.6	+32
G5S	34°39'32"	118°08'20"	-4.799	3.1	2,473.290	753.8587	-4.779	2.6	+20
G4S	34°39'35"	118°08'20"	-4.677	3.2	2,469.980	752.8501	-4.658	0.7	+19
G3S	34°39'39"	118°08'21"	-4.540	3.2	2,465.881	751.6004	-4.514	2.2	+26
G2S	34°39'41"	118°08'21"	-4.607	2.6	2,464.709	751.2433	-4.572	1.9	+35
G1S	34°39'42"	118°08'21"	-4.573	4.1	2,463.882	750.9911	-4.518	6.1	+55
G6E	34°39'44"	118°07'27"	-9.528	2.0	2,467.744	² 752.1683	—	—	—
G4E	34°39'43"	118°08'16"	-5.250	1.3	2,465.964	751.6257	-5.237	1.9	+13
G3E	34°39'43"	118°08'19"	-4.927	3.5	2,464.277	751.1117	-4.906	2.1	+21
G2E	34°39'43"	118°08'20"	-4.753	7.6	2,463.550	750.8900	-4.716	6.0	+37
GNE	34°39'51"	118°08'07"	-6.086	6.4	2,460.296	² 749.8981	—	—	—
			$\bar{x} = 4.2$				$\bar{x} = 3.6$		

See footnotes at end of table.

56 **Table 3.** Microgravity data collected during cycle 2 of the injection, storage, and recovery study at Lancaster, Antelope Valley, California, November 1996 through April 1997—Continued

Gravity station identifier (fig. 20)	Latitude	Longitude	Near completion of injection (April 5–12, 1997)				Change in microgravity from previous survey (μGal)	Change from initial survey	
			Mean change in microgravity (mGal)	Standard deviation (μGal)	Station altitude	Microgravity (μGal)		Microgravity (μGal)	Station altitude (mm)
					feet	meters			
G5N	34°40'05"	118°08'26"	-4.767	4.3	2,441.614	744.2038	+3	+7	+2.4
G3N	34°39'47"	118°08'20"	-4.646	1.3	2,459.700	749.7166	+13	+38	+.8
G2N	34°39'45"	118°08'20"	-4.592	4.1	2,461.430	750.2440	+14	+41	+.4
G1N	34°39'44"	118°08'20"	-4.562	2.5	2462.124	750.4554	+18	+49	+.3
GR	34°40'05"	118°08'09"	-6.095	7.4	—	—	+2	+3	—
G4W	34°39'43"	118°08'36"	-2.572	3.5	—	—	+5	+37	—
G3W	34°39'44"	118°08'28"	-3.599	4.9	2,459.407	749.6272	+11	+49	+.4
G2W	34°39'43"	118°08'25"	-3.982	4.6	2,460.467	749.9504	-2	+32	-.7
G1W	34°39'43"	118°08'24"	-4.157	1.8	2,461.484	750.2602	+5	+39	-1.0
GZERO	34°39'43"	118°08'22"	-4.254	3.5	2,461.619	750.3014	+12	+44	-1.1
G5S	34°39'32"	118°08'20"	-4.769	3.1	—	—	+10	+30	—
G4S	34°39'35"	118°08'20"	-4.653	4.8	2,469.983	752.8509	+5	+24	+.8
G3S	34°39'39"	118°08'21"	-4.510	2.5	2,465.879	751.6000	+4	+30	-.4
G2S	34°39'41"	118°08'21"	-4.563	4.7	2,464.708	751.2431	+9	+44	-.2
G1S	34°39'42"	118°08'21"	-4.507	2.5	2,463.881	750.9908	+11	+66	-.3
G6E	34°39'44"	118°07'27"	-9.519	1.4	—	—	—	+9	—
G4E	34°39'43"	118°08'16"	-5.218	1.9	2,465.966	751.6265	+19	+32	-.8
G3E	34°39'43"	118°08'19"	-4.887	0.6	2,464.279	751.1123	+19	+40	-.6
G2E	34°39'43"	118°08'20"	-4.715	5.0	2,463.550	750.8901	+1	+38	+.1
GNE	34°39'51"	118°08'07"	-6.077	3.8	—	—	—	+9	—
QTZ ³	34°38'43"	118°12'01"	—	—	2,638.7	⁴ 804.3	—	—	—

¹ Altitude measured at bench mark G5aN, located on same concrete pad as gravity station G5N, but outside of extensometer building.

² Altitude measured during March 26–28, 1996.

³ Bedrock promontory used as a stable gravity reference.

⁴ Determined by GPS in 1996.

Table 4. Microgravity data collected during cycle 3 of the injection, storage, and recovery study at Lancaster, Antelope Valley, California, February 1998 and June 1998

[Latitude and longitude are referenced to the North American Datum of 1983 (NAD83) determined using GPS in 1996–97. Gravity measured relative to Quartz Hill bedrock reference station 3.6 miles from injection site (fig. 3). Station altitudes are referenced to the National Geodetic Vertical Datum of 1929 (NGVD29) and were measured by leveling to second-order standards of accuracy. Altitudes for the pre-injection survey were measured on February 17, 1998. mGal, milliGal; μGal , microGal. \bar{x} , mean. —, no data]

Gravity station identifier (fig. 20)	Latitude	Longitude	Pre-injection survey (February 18–25, 1998)				Near-completion of injection (June 6–12, 1998)			Change in microgravity from previous survey (μGal)	
			Mean change in microgravity (mGal)	Standard deviation (μGal)	Station altitude		Mean change in microgravity (mGal)	Standard deviation (μGal)			
					feet	meters					
G8N	34°39'57"	118°08'20"	-4.952	0.4	2,450.716	746.9783	-4.954	5.0	-2		
G5N	34°40'05"	118°08'26"	-4.799	3.9	2,441.609	744.2025	-4.801	.9	-2		
G4N	34°39'50"	118°08'20"	-4.772	1.9	2,456.870	748.8540	-4.766	2.4	+6		
G3N	34°39'47"	118°08'20"	-4.688	1.0	2,459.696	749.7153	-4.681	1.6	+7		
G2N	34°39'45"	118°08'20"	-4.645	3.5	2,461.425	750.2424	-4.626	1.2	+19		
G1N	34°39'44"	118°08'20"	-4.648	1.9	2,462.119	750.4539	-4.608	3.3	+40		
GR	34°40'05"	118°08'09"	-6.104	1.0	—	—	-6.106	3.9	-2		
G5W	34°39'43"	118°08'43"	-1.831	1.7	2,453.583	747.8520	-1.802	2.5	+29		
G4W	34°39'43"	118°08'36"	-2.559	2.1	2,454.684	748.1876	-2.546	4.0	+13		
G3W	34°39'43"	118°08'28"	-3.666	.9	2,459.401	749.6255	-3.629	.7	+37		
G2W	34°39'43"	118°08'25"	-4.022	3.1	2,460.472	749.9519	-4.012	4.0	+10		
G1W	34°39'43"	118°08'24"	-4.193	1.9	2,461.484	750.2603	-4.179	3.2	+14		
GZERO	34°39'43"	118°08'22"	-4.284	1.2	2,461.617	750.3009	-4.263	8.9	+21		
G6S	34°39'22"	118°08'20"	-5.322	1.8	2,484.130	757.1629	-5.315	4.8	+7		
G4S	34°39'35"	118°08'20"	-4.697	2.0	2,469.956	752.8427	-4.662	4.4	+35		
G3S	34°39'39"	118°08'21"	-4.546	2.5	2,465.851	751.5914	-4.532	2.3	+14		
G2S	34°39'41"	118°08'21"	-4.610	2.4	2,464.684	751.2356	-4.583	3.6	+27		
G1S	34°39'42"	118°08'21"	-4.562	3.8	2,463.866	750.9865	-4.536	5.7	+26		
G5E	34°39'43"	118°08'13"	-5.686	1.7	2,467.990	752.2432	-5.658	0.4	+28		
G4E	34°39'43"	118°08'16"	-5.276	2.1	2,465.942	751.6191	-5.235	1.0	+41		
G3E	34°39'43"	118°08'19"	-4.984	2.1	2,464.275	751.1109	-4.957	1.8	+27		
G2E	34°39'43"	118°08'20"	-4.826	2.4	2,463.547	750.8891	-4.809	5.5	+17		
G1E	34°39'43"	118°08'21"	-4.563	2.4	2,462.418	750.5450	-4.521	4.9	+42		
GNE	34°39'51"	118°08'07"	-6.096	1.3	—	—	-6.090	.2	+6		
NW5	34°39'57"	118°08'33"	-3.645	1.1	2,444.944	745.2189	-3.628	1.6	+17		
NW4	34°39'57"	118°08'34"	-3.487	1.0	2,444.379	745.0467	-3.475	3.7	+12		
NW2	34°39'56"	118°08'35"	-3.318	1.7	2,445.158	745.2841	-3.311	1.6	+7		
GSE	34°39'30"	118°08'10"	-6.551	3.9	2,481.580	756.3855	-6.505	4.2	+46		
GSW	34°39'32"	118°08'29"	-3.726	.7	2,471.664	753.3632	-3.706	12.2	+20		
Boat	34°39'25"	118°08'02"	-7.707	1.5	2,489.602	758.8308	-7.679	3.2	+28		
Josh	34°39'43"	118°08'05"	-6.383	2.8	2,468.732	752.4696	-6.356	10.4	+27		
				$\bar{x} = 2.0$					$\bar{x} = 3.6$		

GEODETIC MONITORING

Three geodetic monitoring techniques were used to measure the geographical distribution of land-surface deformation during the injection phase of each cycle: differential leveling of a network of vertical-control bench marks to measure land-surface altitude changes; continuous GPS surveying to monitor land-surface altitude changes at the injection site; and tiltmeter monitoring to measure land-surface inclination changes near the injection site.

Differential-Leveling Network

A differential-leveling network consisting of 124 vertical-control bench marks was installed in September 1995 to monitor land-surface altitude changes near the injection site (fig. 23). The bench marks were spaced about 130 ft apart along four lines radiating in each cardinal direction from near the intersection of Avenue L and 5th Street West. The south and north lines, parallel to 5th Street West, were about 1 mi long. The south line ended about 0.25 mi north of Avenue M and the north line ended at Avenue K. The west and east lines, parallel to Avenue L, were about 0.5 mi long. The west line ended at 10th Street West, but three additional bench marks were installed between 10th Street West and 20th Street West. The east line ended at Sierra Highway, but two additional bench marks were installed between Sierra Highway and 5th Street East. Seven bench marks were installed near the injection wells along a second west-east line which was about 900 ft long. Three bench marks were installed between 5th Street West and the extensometer building. One bench mark was installed inside the extensometer building.

Bench-Mark Installation

Bench marks were installed on steel rods or rebar, in concrete, or on other materials (table 5). Most of the bench marks were installed in 3-foot-deep holes encased by 3-foot lengths of 6-inch-diameter PVC casing to keep the soil from contacting the bench-mark rod. Bench marks installed in 3-foot-deep holes consisted of two 4-foot-long sections of 0.625-inch-diameter copper-plated steel rod or rebar. The rods and rebar were pounded into the soil with a hydraulic hammer. A 3.25-inch-diameter brass tablet, stamped with the bench-mark identifier, was cemented to the top of the rods and rebar with industrial-grade epoxy

(fig. 24). Either brass tablets, stamped with the benchmark identifier, or steel bolts, mounted in concrete, were used for some of the bench marks. Locations where bench marks were installed in concrete surfaces include sidewalks along Avenue L, the well pad at 7N/12W-27P3, and the extensometer building pad. Other bench marks used were a Los Angeles County bench mark and a metal sewer cover.

LACDPW personnel conducted a series of seven GPS surveying sessions (table 6) on October 23 and 24, 1995, to determine the latitude, longitude, and altitude of each bench mark. The GPS surveys were done relative to existing bench marks (regional control points) with known coordinates. Five bench marks (F1147, 104-7, OBAN, SAHARA, and MARGO) measured in 1992 by the USGS and LACDPW were used as regional control points (fig. 25). The first survey was a 6-hour static session during which five new bench marks (ZERO, N35, S35, E20, and W21) were surveyed simultaneously with the two regional control points (F1147 and 104-7) to establish the five new bench marks as local control points near the injection site. In the second survey, the same set of seven bench marks was observed during a 2-hour static session to confirm the results of the first survey. The third, fourth, and fifth surveys were fast static sessions during which base receivers were operated at OBAN, SAHARA, W23, or MARGO and the local control points were observed for a period of about 10 minutes. These surveys were done to provide an independent check of the coordinates for the two regional control points (F1147 and 104-7) and the local control points. The sixth and seventh surveys were fast static sessions during which base receivers were operated at one or more of the local control points and the remaining bench marks were observed for a period of about 10 minutes.

The GPS-measured horizontal coordinates for each bench mark were converted to latitude and longitude determined relative to the North American Datum of 1983 (NAD83). NAD83 is the satellite reference system that most closely approximates the Earth's shape in the Antelope Valley (Ikehara and Phillips, 1994). The GPS-measured vertical coordinate for each bench mark (ellipsoidal height) and the GPS-derived altitude (orthometric height) were used to determine land-surface altitude. The ellipsoid height is the vertical coordinate relative to the satellite reference system, NAD83. Orthometric heights were determined using the GEOID93 model and land-surface altitudes from the 1992 GPS survey (Ikehara and Phillips, 1994). Land-surface altitudes from the 1992 GPS survey were

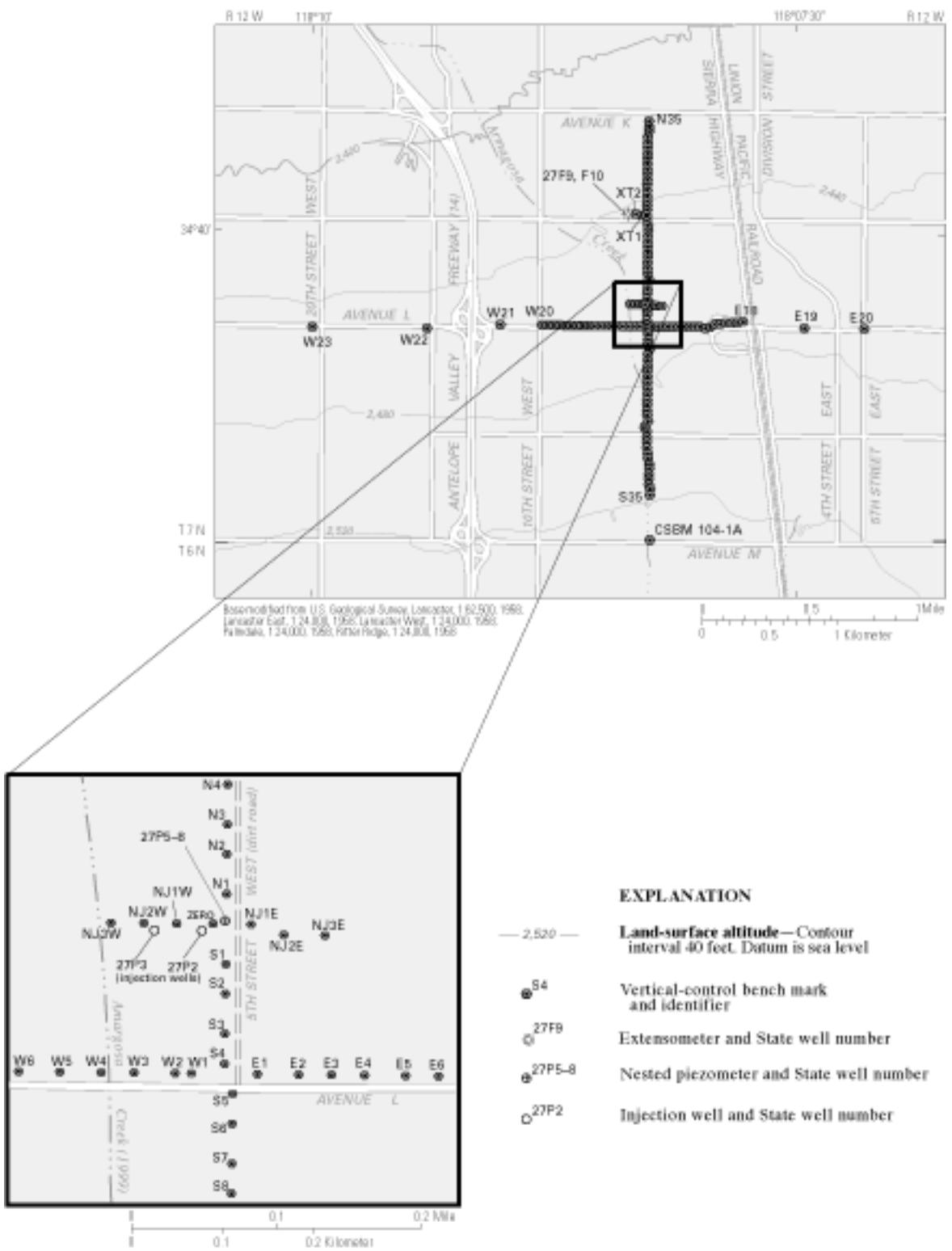


Figure 23. Locations of vertical-control bench marks used in differential-leveling surveys for the injection, storage, and recovery study at Lancaster, Antelope Valley, California.

based on the National Geodetic Vertical Datum of 1929 (NGVD29).

Differential-Leveling Surveys

Several differential-leveling surveys were done by USGS and LACDPW personnel during various phases of the injection, storage, and recovery study

Table 5. Summary of materials used to construct bench marks for the injection, storage, and recovery study at Lancaster, Antelope Valley, California, September 1995 through September 1998

[Bench-mark locations (except where footnoted) shown in figure 23. Because of the constraints of the figure size, only the bench marks within about 800 feet of the injection wells are labeled on the figure—almost all the bench marks in this vicinity were surveyed because the greatest land-surface altitude changes were expected to occur closest to the injection wells]

Bench-mark name	Material	Number of bench marks
Surveying line: south		
S1–S4, S6–S8, S10–S14, S16–S18	Rod	15
S19A, S19B, S20–S35	Rebar	18
S9	Concrete	1
¹ S5, ² S15	Other	2
Surveying line: north		
N1–N19	Rod	19
N20–N35	Rebar	13
Surveying line: west		
W1, W10, W12, W13	Rod	4
W21–W23	Rebar	3
W2–W9, W11, W14–W20	Concrete	16
Surveying line: east		
E1–E9, E14, E15	Rod	11
E10–E13, E16–E20	Concrete	9
Surveying line: short west and east		
NJ1E–NJ3E, NJ1W, NJ3W	Rebar	5
NJ2W	Concrete	1
Extensometer		
XT2	Rebar	1
³ G5aN, XT1	Concrete	2
Injection site		
ZERO	Rod	1
Total		124

¹ Metal Los Angeles County bench mark.

² Metal sewer cover.

³ Bolt set in concrete of extensometer building pad adjacent to G5N. See figure 20.

(table 7). For cycle 1, surveys were done during the pre-injection phase and during the initial and midway parts of the injection phase. For cycle 2, surveys were done during the pre-injection phase, during the initial part of the injection phase, and at the end of the injection phase. A final survey was done during the pre-injection phase for cycle 3.

During all the surveys, almost every bench mark within about 800 ft of the injection wells was surveyed because the greatest land-surface altitude changes were expected to occur closest to the injection wells. Most of the bench marks in the network were surveyed at least once during cycles 1 and 2. Some of the gravity stations established for this study also were surveyed to ensure that observed changes in gravity were due to changes in aquifer mass and not by changes in station altitude owing to aquifer-system deformation (see “Microgravity Surveys” section).

USGS personnel conducted differential leveling of the bench-mark network on September 25 and 26, 1995, using a Wild NA2 instrument and graduated-scale level rods. On September 27 and 28, 1995, LACDPW personnel leveled the bench-mark network using a Wild NA3000 instrument and Invar bar-code rods. The bar-code rods produced results comparable with the conventional graduated-scale rods and thus were used for all subsequent surveys. All the surveys were done to first-order accuracy using second-order methods (Federal Geodetic Control Committee, 1984).

The initial differential-leveling surveys done in late September 1995 began at a previously established bench mark with a known land-surface altitude. The



Figure 24. Typical vertical-control bench mark used for differential-leveling surveys.

altitude of the bench mark [Los Angeles County Surveyor Bench Mark (CSBM) 104-1A, also known as DL 3197] was designated the starting altitude for computing land-surface altitudes of the new bench marks established for this study. CSBM 104-1A is located on Avenue M, about 0.2 mi south of bench mark S35 (fig. 23). CSBM 104-1A was installed in 1967 and was most recently leveled and adjusted in 1991 as part of the Los Angeles County Baseline leveling. The published altitude is 2,531.264 ft (County of Los Angeles, 1991). This bench mark was measured during several leveling surveys between 1967 and 1991, and results of the surveys indicate that there was no change in land-surface altitude at this bench mark during this period. Results of previous land-subsidence studies, however, have shown that notable land subsidence was occurring north of CSBM 104-1A where the sedimentary deposits gradually become more fine-grained (Ikehara and Phillips, 1994).

Data Processing

Differential-leveling surveys were done to measure the difference in altitude between two bench marks. The altitude of each bench mark was computed by adding or subtracting the measured difference in altitude to or from the altitude of the previous bench

mark in the surveying line. The altitudes of the bench marks on the south-north line were computed relative to the altitude of bench mark CSBM 104-1A for about half of the surveys. For surveys that did not extend to CSBM 104-1A, the altitudes on the south-north line were computed relative to the altitude of the southernmost bench mark computed for the previous survey. The altitudes of the bench marks on the west-east line were computed relative to the altitude of bench mark S4, where the west-east line intersects the south-north line. Altitudes of bench marks on the short west-east line near the injection site were computed relative to the altitude of bench mark ZERO. Land-surface altitudes from all differential-leveling surveys are shown in figures 26–29.

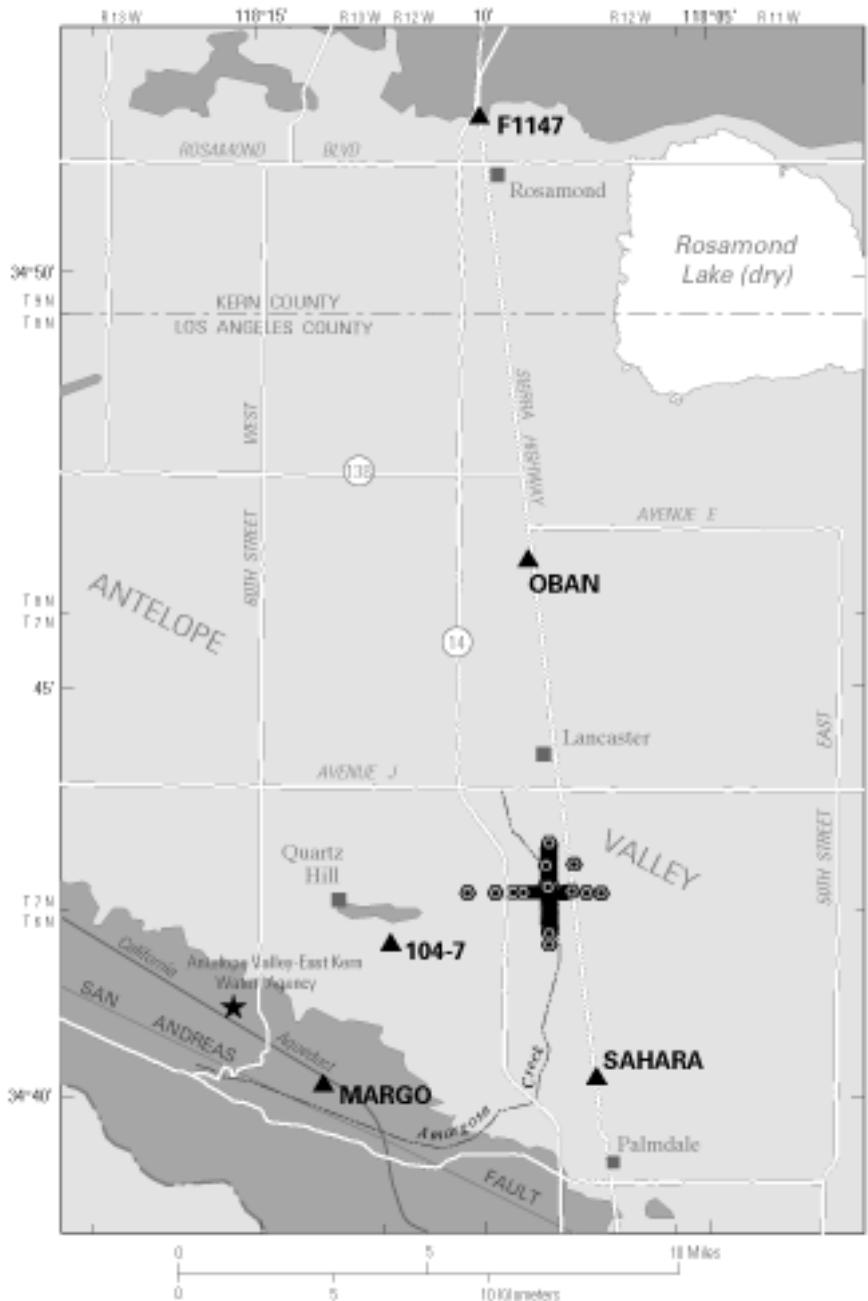
Continuous GPS Surveying

A permanent, continuous GPS station was established at the injection site to monitor land-surface altitude changes. Continuous GPS surveying provided a practical alternative to labor-intensive daily or subdaily (every 3 or 6 hours) differential-leveling surveying. Continuous GPS surveying also measured short-term land-surface altitude changes that could not be measured with periodic differential-leveling surveying.

Table 6. Summary of Global Positioning System (GPS) surveying sessions used to determine coordinates for bench marks in the differential-leveling network for the injection, storage, and recovery study at Lancaster, Antelope Valley, California, October 23 and 24, 1995
[USGS, U.S. Geological Survey]

GPS session	Observation session type	Bench marks used as control points for 6- and 2-hour static sessions and as base receivers for fast static sessions	Bench marks used as unknown points for 6- and 2-hour static points and for fast static rover points	Notes
1	6-hour static	F1147, 104-7 (DL 1373) ¹	ZERO, N35, S35, E20, W21	Control points for this session were also used in 1992 GPS survey (USGS)
2	2-hour static	F1147, 104-7 (DL 1373) ¹	ZERO, N35, S35, E20, W21	Duplicate survey to check repeatability
3	Fast static	OBAN, SAHARA	F1147, 104-7 (DL 1373) ¹ , N35, S35, E20, W21	Independent check on horizontal control
4	Fast static	W23	F1147, 104-7 (DL 1373) ¹ , N35, S35, E20, W21	Coordinates for bench mark W23 are unknown
5	Fast static	MARGO	ZERO, N35, S35, E20, W21	Independent check on horizontal control
6	Fast static	ZERO, N35, S35, E20, W21	NJ3E, NJ3W, well 7N/12W-27F3 (4-44) ¹ , XT2, DE2, W22, W23	Points used in session 6 are in the study area, but not necessarily on a network leg
7	Fast static	ZERO	N1-35, S1-35, E1-20, W1-21, NJ1E-3E, NJ1W-3W	Four primary legs of network and two secondary legs near injection wells

¹ Local identifier



EXPLANATION

- Bedrock
- Alluvium
- Playa surface
- Antelope Valley drainage basin boundary
- 104-7▲** Regional geodetic control point and identifier
- Leveling network bench mark
- Antelope Valley-East Kern Water Agency

Figure 25. Locations of regional geodetic control points used to determine horizontal and vertical coordinates for bench marks in the differential-leveling network for the injection, storage, and recovery study at Lancaster, Antelope Valley, California.

GPS Station Construction and Instrumentation

An antenna mount for the permanent, continuous GPS station (fig. 30A) was constructed in March 1996 about 60 ft east-northeast of injection well 7N/12W-27P2 (fig. 3). The 8-foot-high antenna mount was erected by cementing a 2-inch-diameter steel pipe into the ground. The top of the pipe was braced by four legs of 1.5-inch steel welded to vertical supports projected about 2 ft above land surface. The GPS antenna was secured to the top of the pipe with a reducing fitting and threaded bolt. The GPS receiver, telephone modem, and backup batteries were housed in a nearby enclosure (fig. 30B).

A Trimble 4000SSE dual-frequency (P-code) receiver and a microstrip L1/L2 antenna with a ground plane were used during cycle 1. An Ashtech LD-XII receiver was used during cycle 2; and an Ashtech Z-XII receiver and a Dorne Margolin choke-ring antenna, contributed by the Southern California Integrated GPS Network (SCIGN), were used during cycle 3. The continuous GPS station was incorporated into the SCIGN network under the station name LINJ (Lancaster INjection well) before cycle 3 started.

A temporary continuous GPS station was set up as a base station during cycle 2 because of changes in data collection and processing procedures. The temporary station was 6.43 mi west-southwest of the injection site in the parking lot of the AVEK district office (fig. 1). This location was selected for the temporary base station because it is on bedrock and was considered vertically stable, and because of its proximity to the permanent GPS station. The temporary GPS station also was equipped with an Ashtech LD-XII receiver and a microstrip L1/L2 antenna. A wooden tripod was used to mount the antenna approximately 5 ft above land surface. The GPS receiver and a car battery were stored in a waterproof container adjacent to the tripod (fig. 31).

Data Collection and Processing

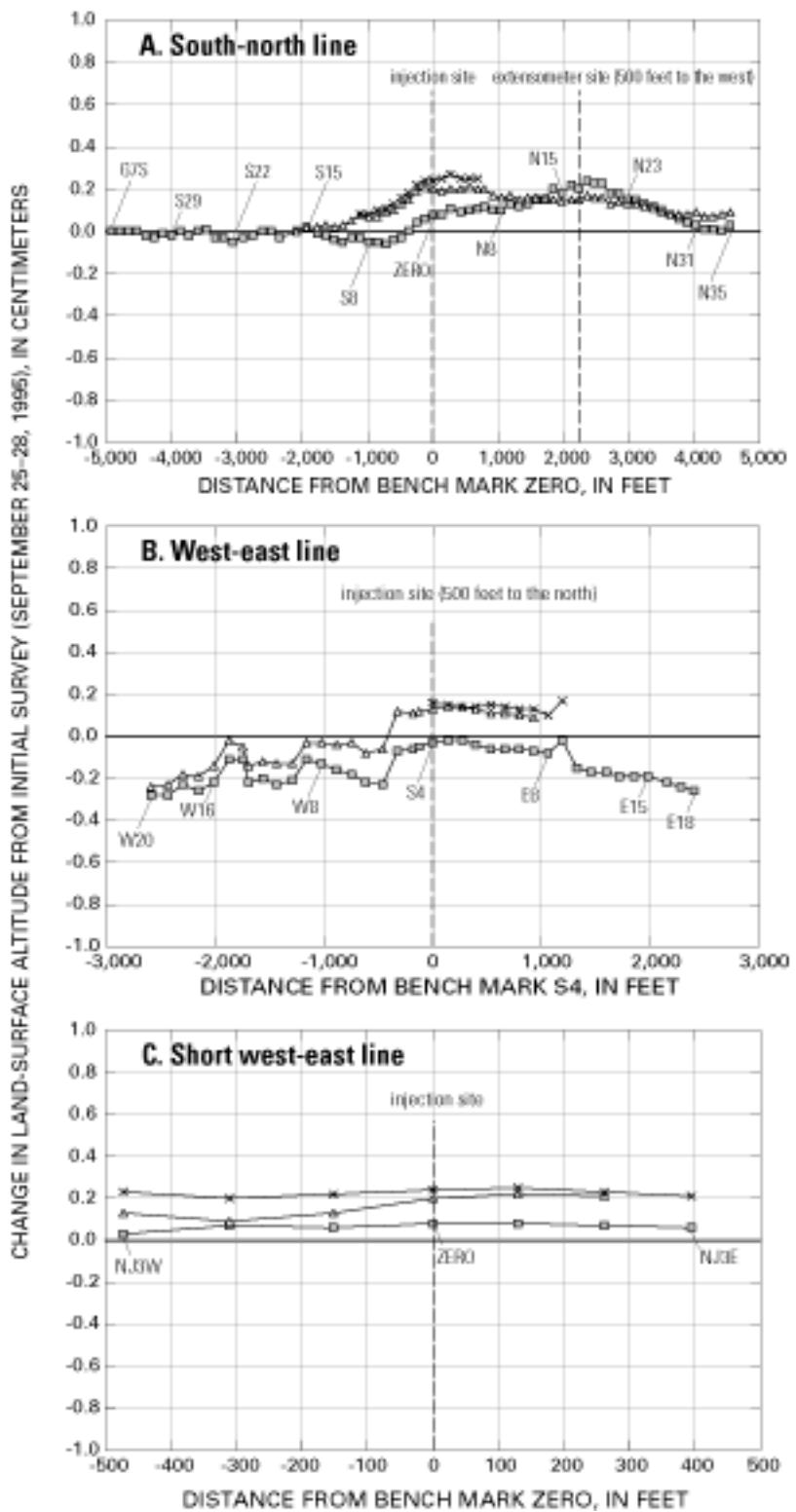
Continuous GPS data were collected at least 7 days prior to the start of the injection phase of each cycle to determine baseline conditions. GPS data were collected only for the initial period of injection during cycles 1 and 2 because it was expected that land-surface altitude changes would occur as a ground-water mound formed during injection. Because the permanent, continuous GPS station became a part of the SCIGN network before the start of cycle 3, it was possible to collect GPS data for all three phases of that cycle. Data were recorded at intervals of either 30 or 120 seconds and compiled into sessions representing 3-, 6-, or 24-hour sessions for various survey periods (table 8). Data were downloaded by modem once a day for cycles 1 and 3 and by laptop computer every 1 to 3 weeks for cycle 2.

GPS data collected during cycles 1 and 3 were processed by computing the daily or subdaily (every 3 or 6 hours) position (latitude, longitude, and land-surface altitude) of the permanent GPS station at the injection site in relation to the known positions of other GPS stations in the SCIGN network (Nancy King, U.S. Geological Survey, written commun., 2000). GPS data collected during cycle 2 were processed by computing the ellipsoid height for the permanent GPS station at the injection site relative to a fixed ellipsoid height for the temporary GPS base station at the AVEK district office parking lot.

Daily solutions, representing the mean land-surface altitude for each 24-hour period, were computed for cycles 1 and 3 using the 24-hour data files from the injection site and three SCIGN stations (Nancy King, U.S. Geological Survey, written commun., 2000). Daily solutions for cycle 2 were computed as the mean land-surface altitude for the 3-hour and 6-hour subdaily data files. Daily solutions are shown in figure 32 as the change in land-surface altitude relative to an initial starting value of zero for the following dates: April 7 to April 13, 1996 (cycle 1); November 6 to December 4, 1996 (cycle 2); April 9 to May 9, 1998 (cycle 3).

Table 7. Survey periods of differential-leveling surveys for the injection, storage, and recovery study at Lancaster, Antelope Valley, California, September 1995 through February 1998

Phase	Survey period		
	Injection cycle 1	Injection cycle 2	Injection cycle 3
Pre-injection	September 25–28, 1995 March 26–27, 1996	November 4, 1996	February 17, 1998
Injection, initial.....	April 15–16, 1996	November 12–15, 1996	
Injection, midway	April 29, 1996		
Injection, end		April 9, 1997	



EXPLANATION

- March 26–27, 1996
- ▲ April 15–16, 1996
- * April 29, 1996

Figure 26. Change in land-surface altitude of bench marks and gravity stations measured during surveys on March 26–27, April 15–16, and April 29, 1996, relative to land-surface altitudes measured on September 25–28, 1995, in Lancaster, Antelope Valley, California. (Gravity stations are denoted by a "G" as the first character of the station identifier.)

Subdaily solutions were computed to determine whether changes in land-surface altitude occurred over periods of less than 24 hours (fig. 33). The subdaily solutions represent the average land-surface altitude for 4-hour periods for cycle 1 and for 3- or 6-hour periods for cycle 2. The same dates used for the daily solutions for cycles 1 and 2 were used for the subdaily solutions for cycles 1 and 2 (figs. 32 and 33, respectively). For cycle 1, the subdaily solutions were computed by reprocessing the 24-hour sessions as six 4-hour

sessions (Nancy King, U.S. Geological Survey, written commun., 2000). For cycle 2, the subdaily solutions were computed by dividing each 24-hour data session into either four 6-hour periods or eight 3-hour periods depending on the number of recorded data sessions (table 8). The subdaily solutions are shown in figure 33 as the change in land-surface altitude relative to an initial starting value of zero. Several of the subdaily solutions for cycle 1 are not shown because of erroneous data.

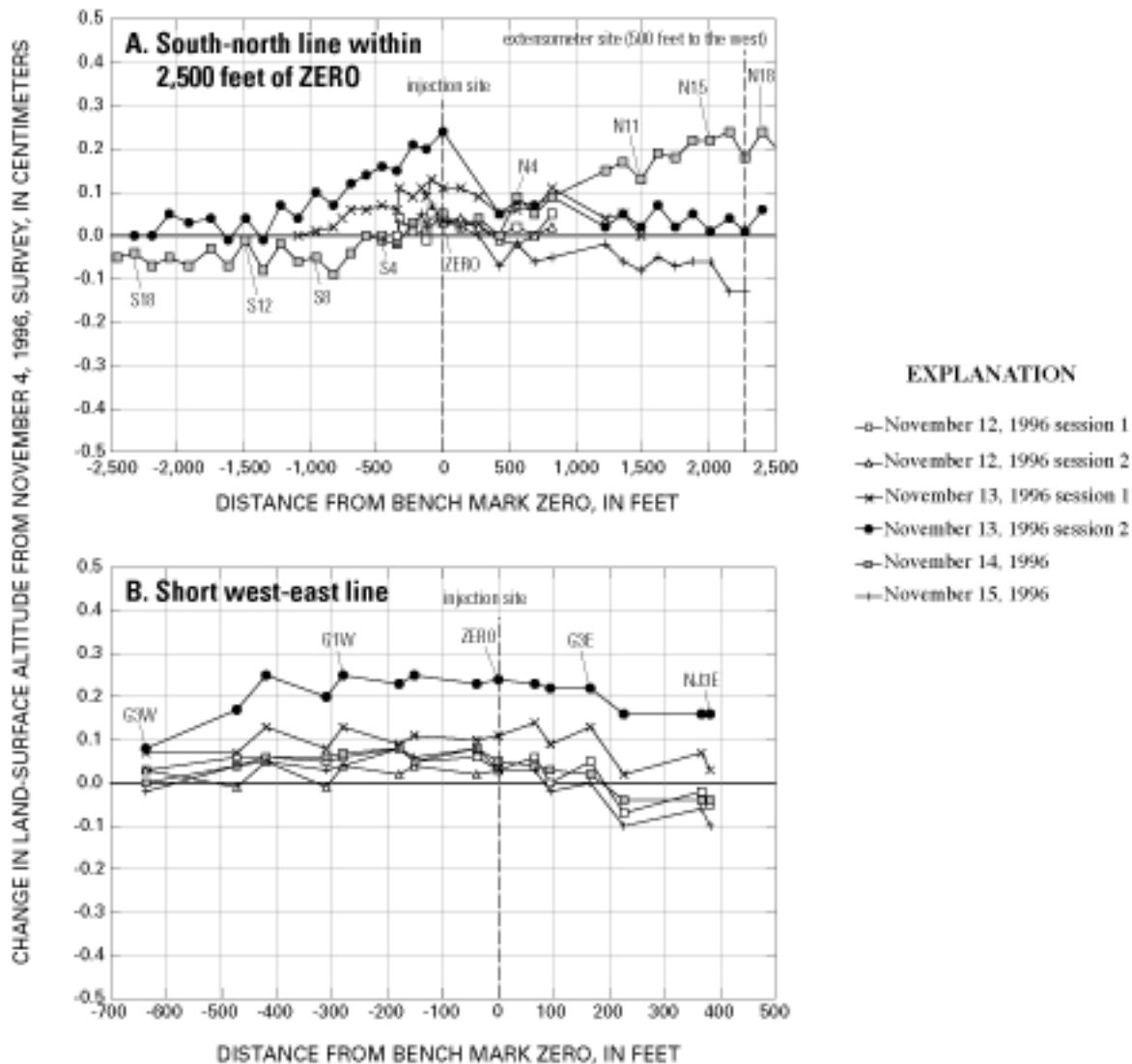
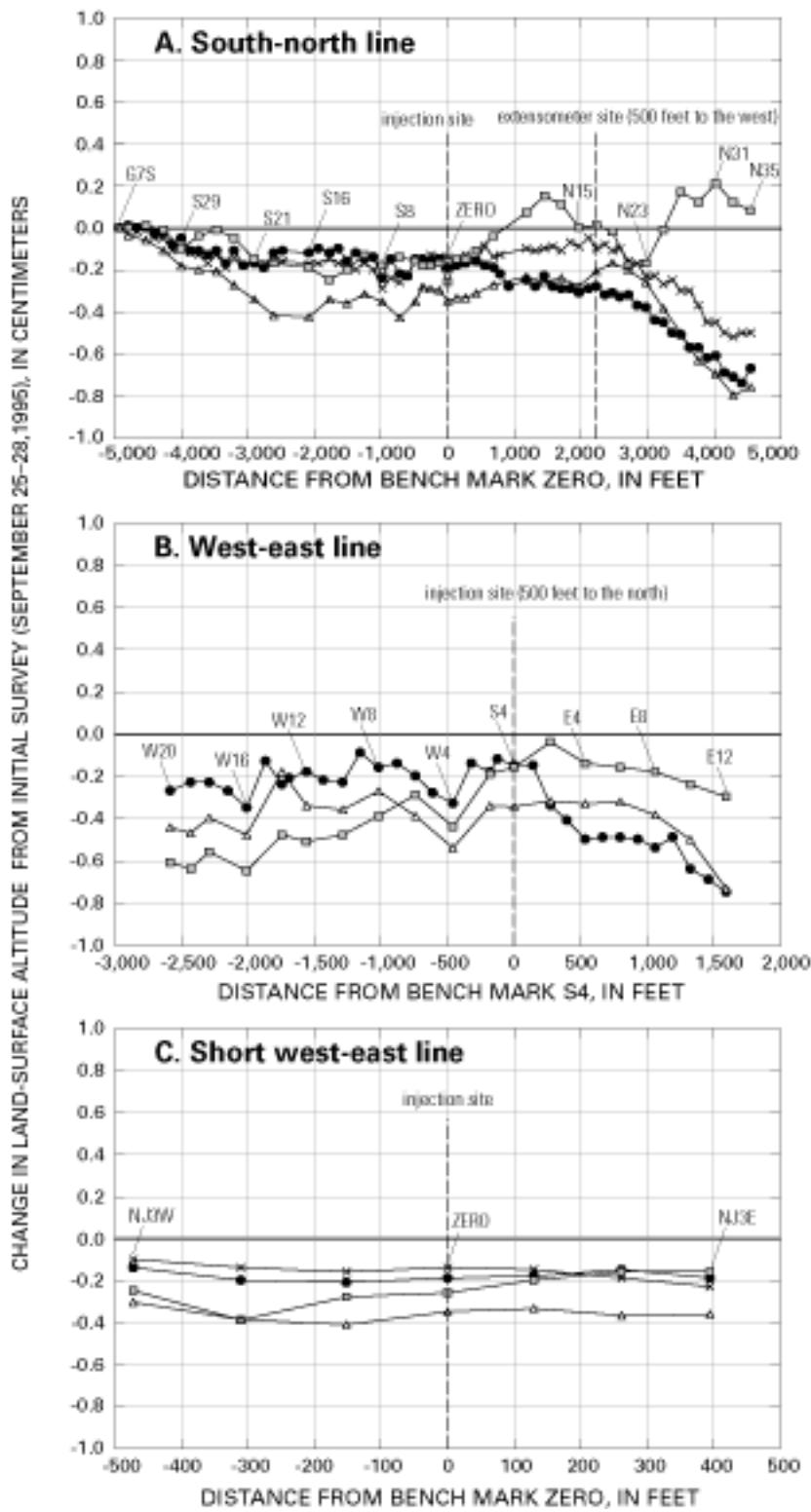


Figure 27. Change in land-surface altitude of bench marks and gravity stations measured during surveys on November 12–15, 1996, relative to land-surface altitudes measured on November 4, 1996, in Lancaster, Antelope Valley, California. (Gravity stations are denoted by a "G" as the first character of the station identifier.)



EXPLANATION

- November 4, 1996
- November 14, 1996
- April 9, 1997
- △ February 17, 1998

Figure 28. Change in land-surface altitude of bench marks and gravity stations measured during surveys on November 4, 1996; November 14, 1996; April 9, 1997; and February 17, 1998, relative to land-surface altitudes measured on September 25–28, 1995, in Lancaster, Antelope Valley, California. (Gravity stations are denoted by a "G" as the first character of the station identifier.)

Tiltmeter Network

A network of biaxial platform tiltmeters (Applied Geomechanics Model 701) was installed near the injection site to monitor the magnitude and direction of ground tilting (Robert Larson, Los Angeles County Department of Public Works, written commun., 1997). Tiltmeters can simultaneously monitor tilt in two directions (north-south and east-west). The resolution of the Model 701 tiltmeters is 0.1 microradian (a microradian is equivalent to 0.000057 degree). Personnel from the LACDPW, Materials Engineering Division, installed and operated the tiltmeters and processed all recorded data.

Installation

Tiltmeters were used to monitor tilt associated with direct well injection during cycle 2. Six tiltmeters were installed in an L-shaped configuration aligned west and north of injection well 7N/12W-27P3 (fig. 34). The three tiltmeters in the western array were positioned at distances of 90, 198, and 755 ft from well 7N/12W-27P3 and identified as sites 1W, 2W, and 3W, respectively. The three tiltmeters in the northern array were positioned at distances of 134, 305, and 1,323 ft

from well 7N/12W-27P3 and identified as sites 1N, 2N, and 3N, respectively.

The tiltmeters were installed 18 inches below land surface in a 2-foot-square (ft^2) lockable, bottomless metal vaults buried in the ground (fig. 35). Each tiltmeter was placed on a concrete block (6 x 6 x 2 inches) embedded in approximately 6 inches of #2-12 filter sand (Robert Larson, Los Angeles County Department of Public Works, written commun., 1997). The sand was placed on ground that had been foot tamped and was used to prevent soil moisture from contacting the instrumentation. A data logger and a 12-volt (V) car battery were installed in the second vault of each array. Cables connecting the battery and the data logger to the tiltmeters were buried under 6 inches of soil to reduce the likelihood of disturbance. Each tiltmeter was set to the high-gain mode (which can measure as much as a 0.5 degree tilt) with the filter on.

Data Collection and Processing

Tiltmeter readings were recorded (in millivolts) on the data logger at 10-minute intervals. Data from each retrieval were combined into a data file that consisted of 12,068 readings. Signal spikes greater than 10 millivolts were deleted. Data were averaged for 6-hour intervals and were converted from millivolts to

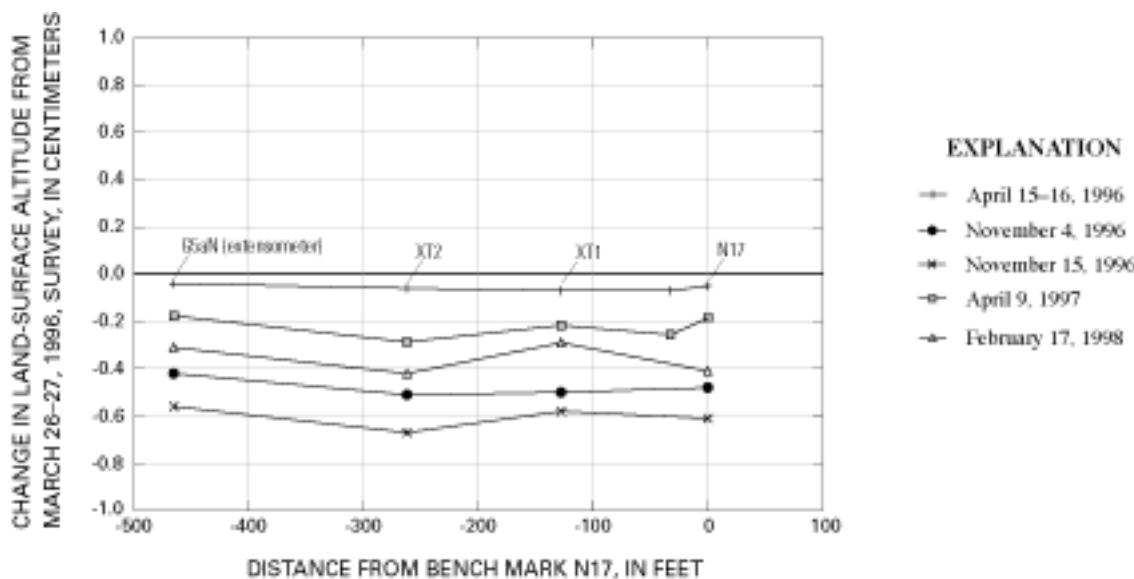


Figure 29. Change in land-surface altitude of bench marks along the extensometer line of the differential-leveling network measured during surveys on April 15–16, 1996; November 4, 1996; November 15, 1996; April 9, 1997; and February 17, 1998, relative to land-surface altitudes measured on March 26–27, 1996, in Lancaster, Antelope Valley, California. (Gravity stations are denoted by a "G" as the first character of the station identifier. G5aN is a bench mark adjacent to the extensometer.)

A.



B.



Figure 30. Permanent Global Positioning System (GPS) station at the injection site in Lancaster, Antelope Valley, California. **A**, Antenna (photographed in September 1998). **B**, Receiver with modem.



Figure 31. Temporary Global Positioning System (GPS) base station at the Antelope Valley–East Kern (AVEK) Water Agency district office in Antelope Valley, California.

Table 8. Survey periods of continuous Global Positioning System (GPS) surveys, data recording intervals, and number and duration of daily data sessions for the injection, storage, and recovery study at Lancaster, Antelope Valley, California, March 1996 through September 1998

Injection cycle	Survey period	Data recording interval, in seconds	Number of data sessions per day and session duration
1	March 26, 1996–April 15, 1996	30	one 24-hour
2	November 5, 1996–November 12, 1996	30	four 6-hour
	November 12, 1996–December 23, 1996	30	eight 3-hour
	December 23, 1996–December 31, 1996	120	four 6-hour
	January 9, 1997–January 30, 1997	120	four 6-hour
3	February 3, 1998–September 30, 1998	30	one 24-hour

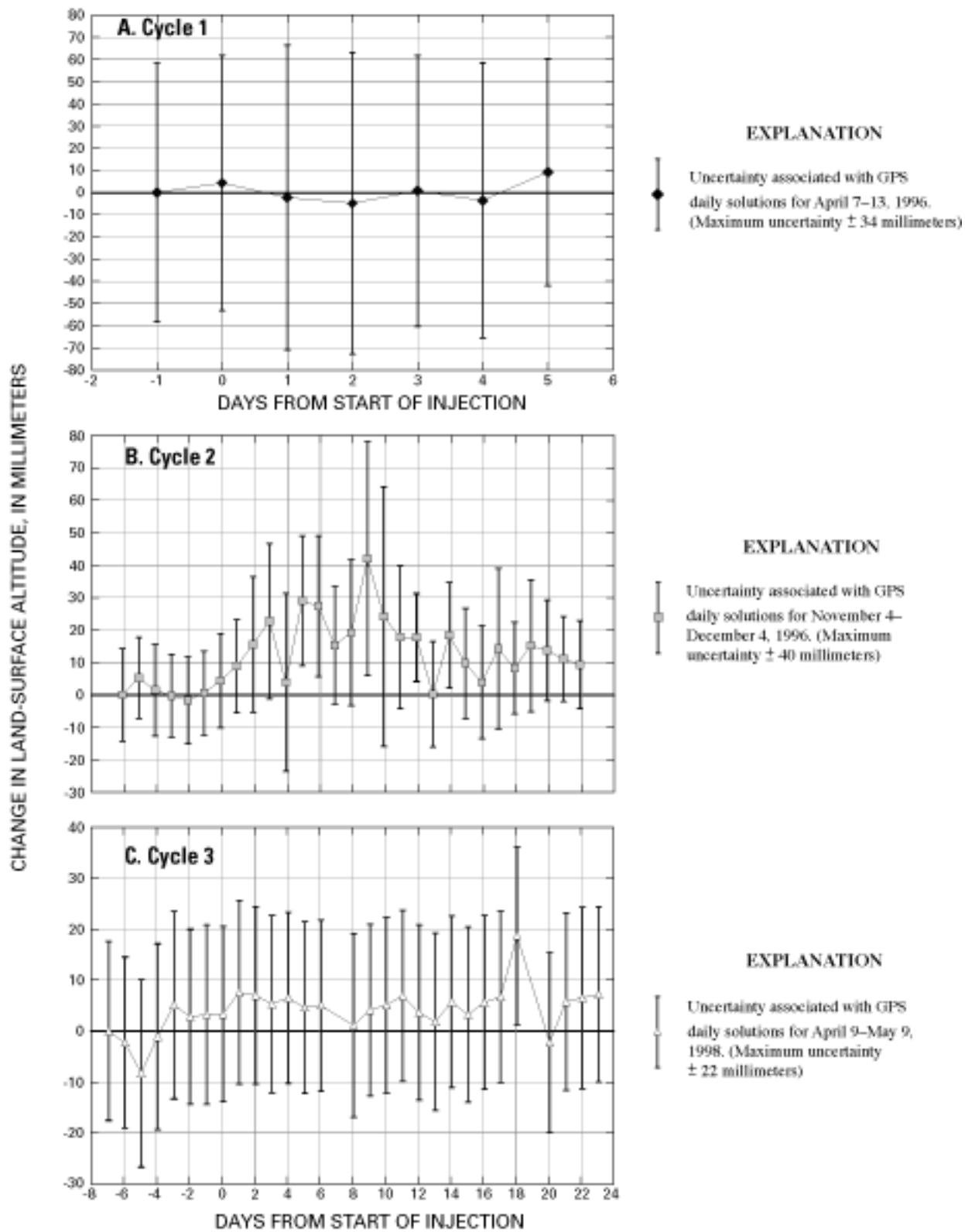


Figure 32. Change in land-surface altitude at the injection site derived from continuous Global Positioning System (GPS) daily solutions for the injection phases of cycles 1, 2, and 3 at Lancaster, Antelope Valley, California. (The uncertainty associated with each graph corresponds to two standard deviations and a confidence interval of 95 percent.)

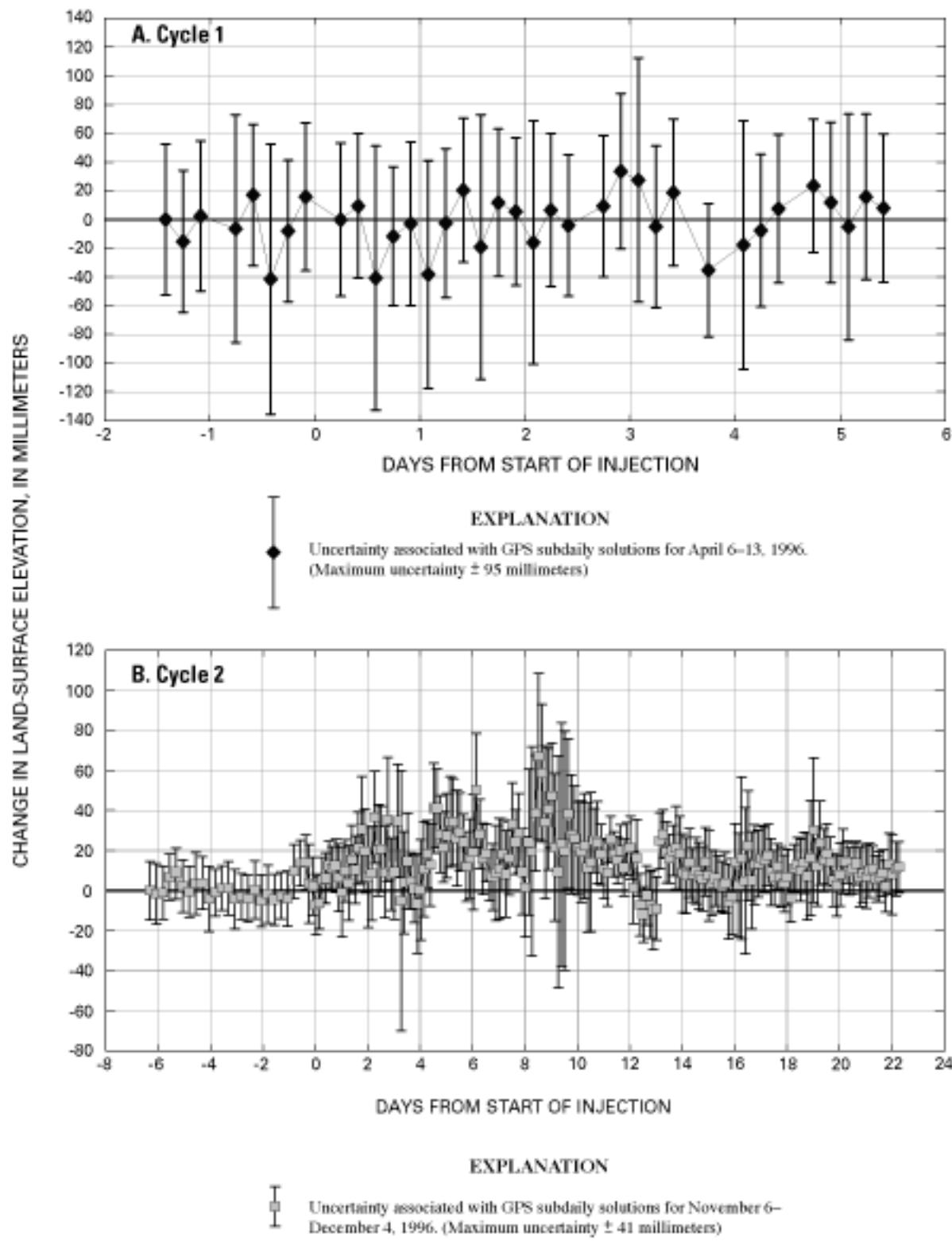


Figure 33. Change in land-surface altitude at the injection site derived from continuous Global Positioning System (GPS) subdaily solutions for the injection phases of cycles 1 and 2 at Lancaster, Antelope Valley, California. (The uncertainty associated with each graph corresponds to two standard deviations and a confidence interval of 95 percent.)



Figure 34. Locations of tiltmeters used to monitor the magnitude and direction of ground tilting associated with direct well injection during cycle 2 at Lancaster, Antelope Valley, California.

microradians (Robert Larson, Los Angeles County Department of Public Works, written commun., 1999).

The magnitude and direction of tilt recorded by the tiltmeters on the northern array during cycle 2 are shown in figure 36. Monitoring of tilt began on November 11, 1996 (about 1 day before the start of injection), and ended on January 30, 1997 (the 80th day of injection). Data for the first, second, and fourth days of data collection by tiltmeters 1N, 2N, and 3N, respectively, are not shown in figure 36 because of large fluctuations in the readings owing to the settling of sand beneath the tiltmeters (Robert Larson, Los Angeles County Department of Public Works, written commun., 1997). On November 25, 1996, less than 2 weeks into injection, tiltmeters in the western array were removed because a poor connection between the battery and the data logger prevented data from being recorded. The last 14 days of data recorded for tiltmeters in the northern array (January 17–30, 1997) are not shown in figure 36 because the computer program used for the analysis was limited to 9,999 readings. The plots from the LACDPW for those 14 days, however, showed essentially no movement (Robert Larson, Los Angeles County Department of Public Works, written commun., 1997).

WATER-CHEMISTRY MONITORING

Water chemistry was monitored during the study to assess the effects of injected water on local ground-water quality. Ground-water samples were collected



Figure 35. Typical tiltmeter installation for recording the magnitude and direction of ground tilting associated with direct well injection at Lancaster, Antelope Valley, California.

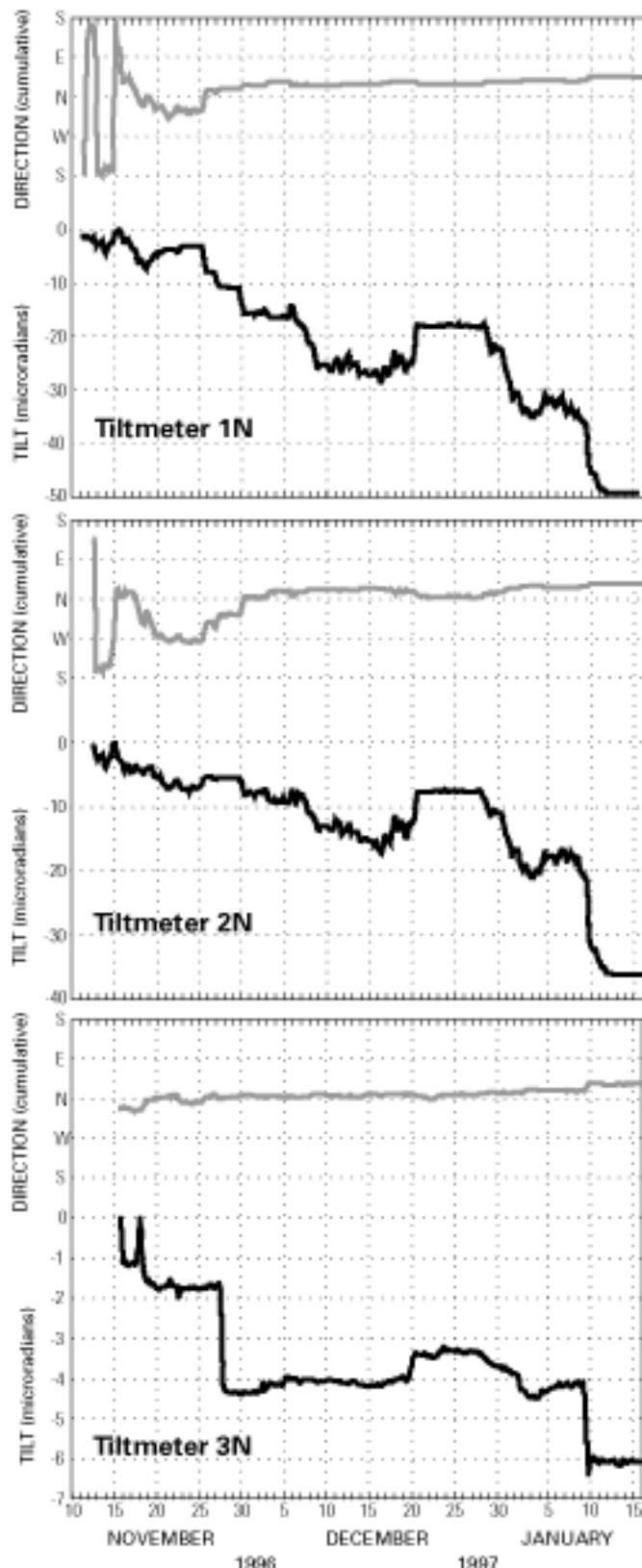


Figure 36. Magnitude and direction of tilt recorded during the injection phase of cycle 2 by tiltmeters 1N, 2N, and 3N in Lancaster, Antelope Valley, California. (From Robert Larson, Los Angeles County Department of Public Works, Materials Engineering Division, written commun., 1997)

from 2 injection wells, 15 production wells, and 5 piezometers (fig. 37) during and after injection, and imported surface-water samples were collected during injection. The samples were analyzed for major ions (table 9, at back of report), trace metals and metalloids (table 10, at back of report), and trihalomethanes (THMs) (table 11, at back of report). The ground-water samples are identified in tables 9–11 by the local well name (see table 1 for corresponding State well number). The imported surface-water samples are identified in the tables by the local well name of the injection well and the name of the water-importing agency: 7N/12W-27P2 [4-32 (AVEK)] and 27P3 [4-34 (AVEK)]. Analyses are presented only for water samples collected during cycles 1 and 2; analyses for water samples collected during cycle 3 will be included in a subsequent report (Miranda Fram, U.S. Geological Survey, written commun., 2000).

The frequencies of sample collection varied depending on (1) the target analyte, (2) the sample location, and (3) the cycle phase. Most of the water samples were collected from the injection wells; they were collected as frequently as daily during the recovery phases. THMs were the most frequently monitored constituents and were collected daily from several wells during the first 1 to 2 months of the recovery phases of cycles 1 and 2. The water samples from the 15 production wells generally were collected only once during each cycle phase. The three production wells (7N/12W-27H3, 27J4, and 27J6) at the Avenue K-8 and Division Street well field (fig. 3) were sampled daily during the first 1 to 2 months of the recovery phases. Water samples were collected from five piezometers once during both the pre-injection and storage phases of cycle 2.

Sample Collection Methods

Water samples were collected from the injection and production wells by personnel from the Los Angeles County Department of Agricultural Commissioner and Weights and Measures (abbreviated hereinafter as LAC). Water samples also were collected from the injection wells by personnel from AVEK as part of the quality-assurance program. Water samples were collected from the nested piezometers by personnel from the USGS.

Water samples from the injection and production wells were collected from a sampling port located on a horizontal part of the well discharge pipe and within several feet of the well head. Water samples from the nested piezometers were collected using a portable, piston-type, submersible pump to prevent aeration of the water during pumping. Prior to sampling, the well

casings, the sampling ports, and the nested piezometer casings were purged of stagnant water. The injection and production wells not in operation at the time of sampling were pumped for several hours prior to sampling. The sampling ports were purged by allowing water to flow through the ports for several minutes. After purging, flow through the sampling port was adjusted to a steady rate to minimize aeration of the water. The nested piezometers were pumped until at least three casing volumes of water were purged and field measurements of pH, specific conductance, and temperature had stabilized (Wilde and Radtke, 1998; Wilde and others, 1998).

Water-chemistry samples were collected in glass and plastic bottles. The samples from nested piezometers were filtered through a 0.45-micrometer (μm) pore-size capsule filter during collection to remove sand and silt. The samples from the production wells were not filtered during collection, but were filtered in the laboratory through a 0.45- μm filter for the analysis of trace metals and metalloids, total dissolved solids, and ultraviolet absorbance (Maureen Smith, Antelope Valley–East Kern Water Agency, written commun., 1999; Wilhelmina Solinap, Los Angeles County Department of Agricultural Commissioner and Weights and Measures, Environmental Toxicology Laboratory, written commun., 2000). THM samples were preserved with sodium thiosulfate; cation and trace metals and metalloid samples were preserved with nitric acid; and total organic carbon samples were preserved with hydrochloric acid. Other chemical constituents did not require chemical preservation (Maureen Smith, Antelope Valley–East Kern Water Agency, written commun., 1999; Wilhelmina Solinap, Los Angeles County Department of Agricultural Commissioner and Weights and Measures, Environmental Toxicology Laboratory, written commun., 1999). All samples were chilled on ice and shipped to the respective LAC and AVEK laboratories.

Specific conductance, pH, water temperature, turbidity, free residual chlorine and total residual chlorine were measured on site for most samples collected from injection and production wells. On the occasions when LAC personnel were not able to make field measurements, specific conductance, pH, and turbidity were measured in the laboratory. Specific conductance, pH, water temperature, dissolved oxygen, and alkalinity were measured on site for samples collected from piezometers. Dissolved oxygen was measured with a flow-through chamber to isolate the sample from atmospheric oxygen.

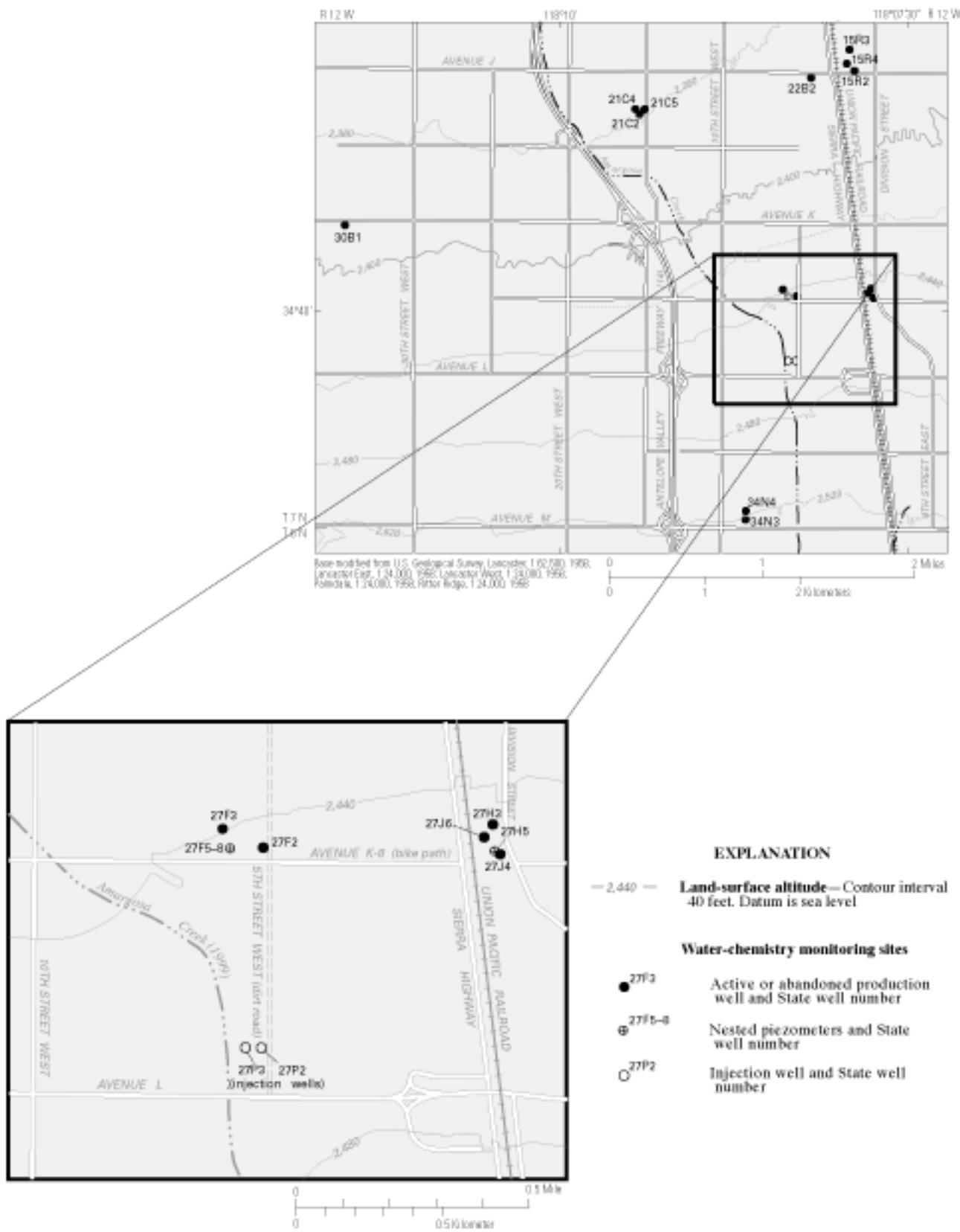


Figure 37. Locations of water-chemistry monitoring sites for cycles 1 and 2 of the injection, storage, and recovery study at Lancaster, Antelope Valley, California.

Table 12. Minimum reporting levels for physical properties and major ions, trace metals and metalloids, and trihalomethanes and associated parameters by agency and summary of analytical methods used to analyze water samples collected during cycles 1 and 2 of the injection, storage, and recovery study at Lancaster, Antelope Valley, California, April 1995 through January 1998

[USGS, U.S. Geological Survey; LAC, Los Angeles County Department of Agricultural Commissioner and Weights and Measures; AVEK, Antelope Valley–East Kern Water Agency; MBAS, Methylene Blue Active Substance. CaCO₃, calcium carbonate; CHCl₂Br, bromodichloromethane; CHBr₃, bromoform; CHCl₃, chloroform; CHBr₂Cl, dibromochloromethane; TTHM, total trihalomethanes. TON, threshold odor number; NTU, nephelometric turbidity unit; mg/L, milligram per liter; µS/cm, microsiemen per centimeter; °C, degrees Celsius; µg/L, microgram per liter; /cm, per centimeter. <, less than; na, not applicable]

Analytical method references:

Standard methods (SM)

All SMs are from “Standard Methods for the Examination of Water and Wastewater” (American Public Health Association, 1995)

U.S. Environmental Protection Agency (EPA) method number

EPA 300.0 A, “Methods for the Determination of Inorganic Substances in Environmental Samples” (U.S. Environmental Protection Agency, 1993)

EPA 415.1, “Methods for the Determination of Water and Wastes” (U.S. Environmental Protection Agency, 1983)

EPA 502.2, “Methods for the Determination of Organic Compounds in Drinking Water” (U.S. Environmental Protection Agency, 1988)

EPA 524.2, “Methods of the Determination of Organic Compounds in Drinking Water Supplement II” (U.S. Environmental Protection Agency, 1992)

U.S. Geological Survey Techniques of Water-Resources Investigations (USGS TWRI)

All methods are from chapter A6, Field Measurements (Wilde and others, 1998)

Property or constituent (Unit of measurement)	Minimum reporting level	Reporting agency	Analytical method reference
Physical properties and major ions			
Dissolved oxygen (mg/L)	0	USGS	USGS TWRI 6.2.1: Amperometric Method
pH (standard units)	0	LAC	SM 4500-H+ B: Electrometric Method
	0	AVEK	SM 4500-H+ B: Electrometric Method
	0	USGS	USGS TWRI 6.4: pH
Specific conductance (µS/cm)	1	LAC	SM 2510 B: Conductivity
	1	AVEK	SM 2510 B: Conductivity
	1	USGS	USGS TWRI 6.3: Specific Electrical Conductance
Temperature (°C)	na	LAC	SM 2550 B: Temperature
	na	USGS	USGS TWRI 6.1: Temperature
Hardness, total (mg/L as CaCO ₃)	5	LAC	SM 2340 C: EDTA Titrimetric Method
Calcium, dissolved (mg/L)	2.0	LAC	SM 3500-Ca D: EDTA Titrimetric Method
Magnesium, dissolved (mg/L)	.1	LAC	SM 3500-Mg E: Calculation Method
Potassium, dissolved (mg/L)	.1	LAC	SM 3500-K D: Flame Emission Photometric Method
Sodium, dissolved (mg/L)	5.0	LAC	SM 3500-Na D: Flame Emission Photometric Method
Alkalinity, total (mg/L as CaCO ₃)	4	LAC	SM 2320 B: Titration Method
	1	USGS	USGS TWRI 6.6.4.B: Inflection Point Titration Method
Chloride, dissolved (mg/L)	2.0	LAC	SM 4110 B: Ion Chromatography with Chemical Suppression of Eluent Conductivity
	2.0	AVEK	EPA 300.0 A: Suppressed Ion Chromatography
Fluoride, dissolved (mg/L)	.1	LAC	SM 4110 B: Ion Chromatography with Chemical Suppression of Eluent Conductivity
Sulfate, dissolved (mg/L)	.5	LAC	SM 4110 B: Ion Chromatography with Chemical Suppression of Eluent Conductivity
Nitrate (mg/L)	.03	LAC	SM 4110 B: Ion Chromatography with Chemical Suppression of Eluent Conductivity
Apparent color, unfiltered (units)	0	LAC	SM 2120 B: Visual Comparison Method
Odor threshold (TON)	0	LAC	SM 2150 B: Threshold Odor Test
Dissolved solids (mg/L)	5	LAC	SM 2540 C: Total Dissolved Solids Dried at 180 degrees Celsius
Turbidity (NTU)	<.1	LAC	SM 2130 B: Nephelometric Method
MBAS (mg/L)	.05	LAC	SM 5540 C: Anionic Surfactants as MBAS

Table 12. Minimum reporting levels for physical properties and major ions, trace metals and metalloids, and trihalomethanes and associated parameters by agency and summary of analytical methods used to analyze water samples collected during cycles 1 and 2 for the injection, storage, and recovery study at Lancaster, Antelope Valley, California, April 1995 through January 1998—Continued

Property or constituent (Unit of measurement)	Minimum reporting level	Reporting agency	Analytical method reference
Trace metals and metalloids			
Aluminum, dissolved ($\mu\text{g/L}$)	50	LAC	SM 3113 B: Electrothermal Atomic Absorption Spectrometric Method
Antimony, dissolved ($\mu\text{g/L}$)	6	LAC	SM 3113 B: Electrothermal Atomic Absorption Spectrometric Method
Arsenic, dissolved ($\mu\text{g/L}$)	2	LAC	SM 3113 B: Electrothermal Atomic Absorption Spectrometric Method
Barium, dissolved ($\mu\text{g/L}$)	100	LAC	SM 3113 B: Electrothermal Atomic Absorption Spectrometric Method
Beryllium, dissolved ($\mu\text{g/L}$)	1	LAC	SM 3113 B: Electrothermal Atomic Absorption Spectrometric Method
Cadmium, dissolved ($\mu\text{g/L}$)	1	LAC	SM 3113 B: Electrothermal Atomic Absorption Spectrometric Method
Chromium, total ($\mu\text{g/L}$)	10	LAC	SM 3113 B: Electrothermal Atomic Absorption Spectrometric Method
Copper, dissolved ($\mu\text{g/L}$)	50	LAC	SM 3113 B: Electrothermal Atomic Absorption Spectrometric Method
Iron, dissolved ($\mu\text{g/L}$)	100	LAC	SM 3111 B: Direct Air-Acetylene Flame Method
Lead, dissolved ($\mu\text{g/L}$)	5	LAC	SM 3113 B: Electrothermal Atomic Absorption Spectrometric Method
Manganese, dissolved ($\mu\text{g/L}$)	30	LAC	SM 3111 B: Direct Air-Acetylene Flame Method
Mercury, dissolved ($\mu\text{g/L}$)	1	LAC	SM 3112 B: Cold-Vapor Atomic Absorption Spectrometric Method
Nickel, dissolved ($\mu\text{g/L}$)	10	LAC	SM 3113 B: Electrothermal Atomic Absorption Spectrometric Method
Selenium, dissolved ($\mu\text{g/L}$)	5	LAC	SM 3113 B: Electrothermal Atomic Absorption Spectrometric Method
Silver, dissolved ($\mu\text{g/L}$)	10	LAC	SM 3113 B: Electrothermal Atomic Absorption Spectrometric Method
Thallium, dissolved ($\mu\text{g/L}$)	1	LAC	SM 3113 B: Electrothermal Atomic Absorption Spectrometric Method
Zinc, dissolved ($\mu\text{g/L}$)	50	LAC	SM 3111 B: Direct Air-Acetylene Flame Method
Trihalomethanes and associated parameters			
Ultraviolet absorbance (UV_{254} (/cm))	0	AVEK	SM 5910 B: Ultraviolet Absorption Method (modified)
Free residual chlorine (mg/L)	trace	AVEK	SM 4500-Cl G: DPD Colorimetric Method
Total residual chlorine (mg/L)	0.1	LAC	SM 4500-Cl G: DPD Colorimetric Method
	trace	AVEK	SM 4500-Cl G: DPD Colorimetric Method
Total organic carbon (mg/L)	1.0	LAC	EPA 415.2: UV Promoted Oxidation Method
	.5	AVEK	SM 5310 C: Persulfate-Ultraviolet Oxidation Method
CHCl_2Br ($\mu\text{g/L}$)	.5	LAC	EPA 524.2: Capillary Column Gas Chromatography - Mass Spectrometry
	.5	AVEK	EPA 502.2: Restek 502.2 column, purge, and trap EICD
CHCl_2Br Formation Potential ($\mu\text{g/L}$)	.5	LAC	SM 5710 B: Trihalomethane Formation Potential (THMFP)
CHBr_3 ($\mu\text{g/L}$)	.5	LAC	EPA 524.2: Capillary Column Gas Chromatography - Mass Spectrometry
	.5	AVEK	EPA 502.2: Restek 502.2 column, purge, and trap EICD
CHBr_3 Formation Potential ($\mu\text{g/L}$)	.5	LAC	SM 5710 B: Trihalomethane Formation Potential (THMFP)
CHCl_3 ($\mu\text{g/L}$)	.5	LAC	EPA 524.2: Capillary Column Gas Chromatography - Mass Spectrometry
	.5	AVEK	EPA 502.2: Restek 502.2 column, purge, and trap EICD
CHCl_3 Formation Potential ($\mu\text{g/L}$)	.5	LAC	SM 5710 B: Trihalomethane Formation Potential (THMFP)
CHBr_2Cl ($\mu\text{g/L}$)	.5	LAC	EPA 524.2: Capillary Column Gas Chromatography - Mass Spectrometry
	.5	AVEK	EPA 502.2: Restek 502.2 column, purge, and trap EICD
CHBr_2Cl Formation Potential ($\mu\text{g/L}$)	.5	LAC	SM 5710 B: Trihalomethane Formation Potential (THMFP)
TTHM ($\mu\text{g/L}$)	.5	LAC	EPA 524.2: Capillary Column Gas Chromatography - Mass Spectrometry
	.5	AVEK	EPA 502.2: Restek 502.2 column, purge, and trap EICD
TTHM Formation Potential ($\mu\text{g/L}$)	.5	LAC	SM 5710 B: Trihalomethane Formation Potential (THMFP)

Analytical Methods

The samples collected from the injection and production wells by LAC personnel and from the nested piezometers by USGS personnel were analyzed at the Los Angeles County Department of Agricultural Commissioner and Weights and Measures Environmental Toxicology Laboratory. The samples collected by AVEK personnel were analyzed at the Antelope Valley–East Kern Water Agency Laboratory. Laboratory analyses and field measurements were done according to the referenced methods listed in table 12.

Quality control of laboratory analyses consisted of a combination of calibration standards, equipment and sample blanks, matrix spikes, matrix-spoke duplicates, and duplicate samples. The number of quality-control samples run with each batch of samples depended on the analytical method. For example, duplicates, spikes, and blanks each accounted for about 10 percent of the total number of samples analyzed by AVEK for THMs, chloride, and total organic carbon (Maureen Smith, Antelope Valley–East Kern Water Agency, written commun., 2001). If the acceptable ranges for the quality control samples were exceeded, the analytical results of the collected samples were rejected and the samples reanalyzed. Acceptable ranges for the quality-control samples were plus or minus 10 percent for major ions, plus or minus 25 percent for trace metals and metalloids, and plus or minus 20 percent for THMs (Los Angeles County Department of Public Works, 2000; Maureen Smith, Antelope Valley–East Kern Water Agency, written commun., 2001).

FLOW-RATE MONITORING

Flow rates at the injection wells were monitored with electromagnetic bi-directional flowmeters (fig. 38) to estimate the volumes of injected and extracted water and to help maintain a constant rate of flow. The flowmeters were accurate to 0.5 percent of flow rate. The flowmeters were installed within a straight segment of each well's discharge pipe to avoid turbulent flow that could cause inaccurate readings. Flow rates were output to digital displays on each flowmeter and at remote enclosures in an electrical control panel near injection well 7N/12W-27P2. The combined flow rate and cumulative volume was

displayed on a separate remote enclosure when both wells were operating simultaneously.

Data Collection

Flowmeter output initially was recorded on a data logger at the extensometer site. Flowmeter data were recorded at time intervals ranging from 1 to 15 minutes. In November 1996, prior to the beginning of cycle 2, a data logger was installed at the injection site owing to concerns about potential signal degradation between the flowmeters and the data logger at the extensometer site. The flow rates recorded on the data logger at the extensometer site were as much as 2.5 percent less than the flow rates recorded on the data logger at the injection site. The flow rates recorded on the data logger at the injection site were comparable to real-time flow rates displayed at both flowmeters and at the remote enclosures at the electrical control panel. Therefore, only data from the data logger at the injection site for cycles 2 and 3 are shown in this report.

Data Processing

Flowmeter data were downloaded from the data logger to a laptop computer during the weekly or bimonthly field visits from April 1996 through September 1998. Following each field visit, the data were entered into the USGS NWIS database. Flowmeter output (in millivolts) was recorded separately for each injection well and then converted to flow rates in gallons per minute using the relation derived from a least-squared regression of the calibration data:

$$FL = 0.9375(V) + (-375), \quad (3)$$

where

FL is the computed flow rate, in gallons per minute;

0.9375 is the slope of the least-squares regression equation, in gallons per minute per millivolt;

V is the flow meter output, in millivolts; and

-375 is the offset (y -intercept) of the least-squares regression equation, in gallons per minute.

Injection and extraction flow rates for the period April 1996 through September 1998 are shown in figure 39.



Figure 38. Flowmeter used to measure injection and extraction flow rates at injection well 7N/12W-27P3 in Lancaster, Antelope Valley, California.

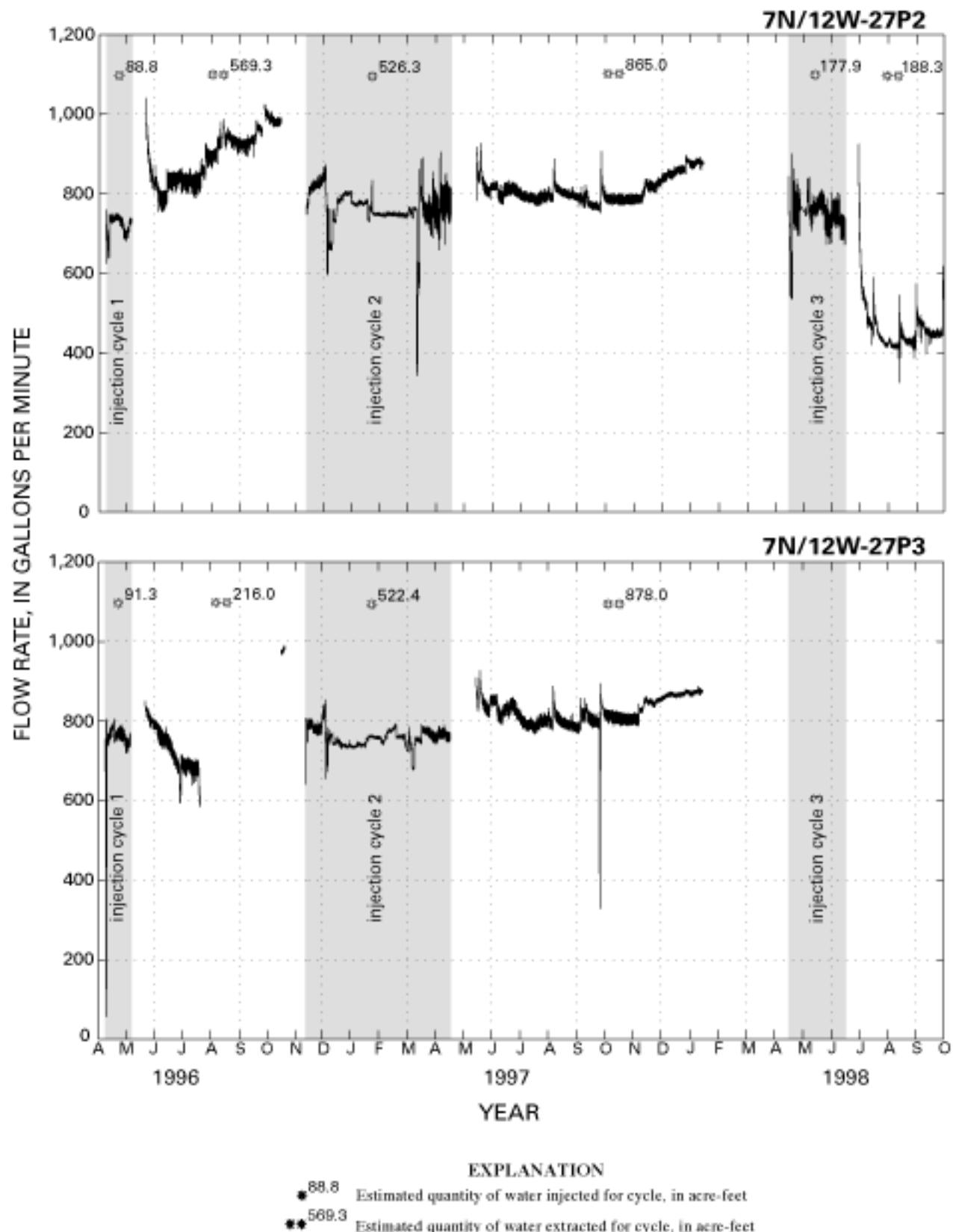


Figure 39. Injection and extraction flow rates at injection wells 7N/12W-27P2 and 27P3 in Lancaster, Antelope Valley, California, April 1996 through September 1998.

SUMMARY

A series of freshwater injection, storage, and recovery tests was done from September 1995 through September 1998 to evaluate the feasibility of artificially recharging ground water in the Lancaster area of the Antelope Valley, California. The tests consisted of three cycles of injection, storage, and recovery. Data were collected from various networks established to monitor vertical deformation of the aquifer system, water-level fluctuations, land-surface deformation, water chemistry, and injection and extraction flow rates.

Data were collected from a dual extensometer, 10 nested piezometers, 1 barometer, 27 active or abandoned production wells, 31 gravity stations, 124 bench marks, 1 permanent and 1 temporary continuous Global Positioning System (GPS) station, 3 tiltmeters, and 2 electromagnetic flowmeters. Vertical deformation, barometric pressure, and flow rates were monitored continuously. Water levels were continuously measured in some piezometers and wells and periodically measured in others. Microgravity surveys and geodetic surveys (differential leveling, GPS, and tiltmeter) generally were conducted during periods of direct well injection.

This report presents descriptions of direct well injection site selection and test design; installation of the various monitoring networks; instrumentation; methods of data collection, processing, and analysis; and lithologic and geophysical logs. It also provides illustrations of extensometer and nested piezometer construction, and graphic and tabular presentations of the data. It is one of five U.S. Geological Survey reports describing a series of injection tests at Lancaster, California, which were designed to assess the feasibility of implementing an injection program as part of a management strategy to halt the decline of ground-water resources and avoid future land subsidence.

REFERENCES CITED

American Public Health Association, American Water Works Association, and Water Pollution Control Federation, 1995, Standard methods for the examination of water and wastewater, 19th edition: Washington, D.C.

Brenda, W.K., Erd, R.C., and Smith, W.C., 1960, Core logs from five test holes near Kramer, California: U.S. Geological Survey Bulletin 1045-F, p. 319–393.

Bloyd, R.M., Jr., 1967, Water resources of the Antelope Valley–East Kern Water Agency area, California: U.S. Geological Survey Open-File Report 67-20, 73 p.

Carlson, C.S., Leighton, D.A., Phillips, S.P., and Metzger, L.F., 1998, Regional water table (1996) and water-table changes in the Antelope Valley ground-water basin, California: U.S. Geological Survey Water-Resources Investigations Report 98-4022, 2 map sheets.

County of Los Angeles, Road Department, 1991, Precise bench mark list, Palmdale quad, 1991 adjustment: Los Angeles Calif., 41 p.

Dibblee, T.W., Jr., 1967, Areal geology of the western Mojave Desert, California: U.S. Geological Survey Professional Paper 522, 153 p.

Durbin, T.J., 1978, Calibration of a mathematical model of the Antelope Valley ground-water basin, California: U.S. Geological Survey Water-Supply Paper 2046, 51 p.

Dutcher, L.C., and Worts, G.F., 1963, Geology, hydrology, and water supply of Edwards Air Force Base, Kern County, California: U.S. Geological Survey Open-File Report 43-05, 225 p.

Federal Geodetic Control Committee, 1984, Standards and specifications for geodetic control networks: Rockville, Maryland, National Oceanic and Atmospheric Administration, 29 p.

Hanson, R.T., 1989, Aquifer-system compaction, Tucson Basin and Avra Valley, Arizona: U.S. Geological Survey Water-Resources Investigations Report 88-4172, 69 p.

Ikehara, M.E., and Phillips, S.P., 1994, Determination of land subsidence related to ground-water-level declines using global positioning system and leveling surveys in Antelope Valley, Los Angeles and Kern Counties, California, 1992: U.S. Geological Survey Water-Resources Investigations Report 94-4184, 101 p.

LaCoste and Romberg, 1997, Instruction manual, model G and D gravity meters: Austin, Texas, LaCoste and Romberg, 122 p.

Lapham, W.W., Wilde, F.D., and Koterba, M.T., 1997, Guidelines and standard procedures for studies of ground-water quality: Selection and installation of wells, and supporting documentation: U.S. Geological Survey Water-Resources Investigations Report 96-4233, 110, p.

Londquist, C.J., Rewis, D.L., Galloway, D.L., and McCaffrey, W.F., 1993, Hydrogeology and land subsidence, Edwards Air Force Base, Antelope Valley, California, January 1989–December 1991: U.S. Geological Survey Water-Resources Investigations Report 93-4114, 71 p.

Los Angeles County Department of Public Works, 2000, Lancaster subbasin aquifer storage and recovery (ASR) demonstration project final report: Los Angeles County Department of Public Works, Waterworks and Sewer Maintenance Division, Waterworks District 40, Antelope Valley, Water Quality and Engineering Section, Water Resources Unit, about 263 p.

Mabey, D.R., 1960, Gravity survey of the western Mojave Desert, California: U.S. Geological Survey Professional Paper 316-D, p. 51–73.

Munsell Color, 1975, Munsell soil color charts: Baltimore, Maryland, Munsell Color, Macbeth Division of Kollmorgen Corporation.

Riley, F.S., 1986, Developments of borehole extensometry in Johnson, A.I., Carbognin, Laura, and Ubertini, L., eds., Land subsidence: International Association of Hydrological Sciences Publication no. 151, 939 p.

Rummel, Michelle, 1996, Aquifer hydraulic properties determined from the frequency response of water levels in wells to earth tides and atmospheric loading: unpublished thesis, California State University, Sacramento, 46 p.

Sneed, Michelle, and Galloway, D.L., 2000, Aquifer-system compaction and land subsidence: Measurements, analyses, and simulations—the Holly site, Edwards Air Force Base, Antelope Valley, California: U.S. Geological Survey Water-Resources Investigations Report 00-4015, 65 p.

U.S. Environmental Protection Agency, 1983, Methods for chemical analysis of water and wastes: Cincinnati, Ohio, Environmental Monitoring and Support Laboratory, EPA/600/4-79-020.

_____, 1988 (revised July 1991), Methods for the determination of organic compounds in drinking water: Cincinnati, Ohio, Environmental Monitoring and Support Laboratory, EPA/600/4-88-039.

_____, 1992, Methods for the determination of organic compounds in drinking water, Supplement II: Cincinnati, Ohio, Environmental Monitoring and Support Laboratory, EPA/600/R-92-129.

_____, 1993, Methods for the determination of inorganic substances in environmental samples: Cincinnati, Ohio, Environmental Monitoring and Support Laboratory, EPA/600/R-93/100.

Western Regional Climate Center, Southern California Climate Summaries: accessed July 10, 1999 at URL <http://www.wrcc.dri.edu/summary/climsmca.html/>

Wilde, F.D. and Radtke, D.B., eds., 1998, National field manual for the collection of water-quality data: U.S. Geological Survey Techniques for Water-Resources Investigations, book 9, chap. A6, Field measurements, variously paged.

Wilde, F.D., Radtke, D.B., Gibbs, Jacob, and Iwatsubo, R.T., eds., 1998, National field manual for the collection of water-quality data—Collection of water samples: U.S. Geological Survey Techniques for Water-Resources Investigations, book 9, chap. A4, variously paged.

APPENDIX A. DISCUSSION ON PREPARING FOR A MICROGRAVITY SURVEY

Prior to the start of each microgravity survey, the gravity meter was taken to the Quartz Hill bedrock reference station for adjustment, referred to as reranging, to bring the range of the fine nulling dial to within the range of the gravitational force at Quartz Hill. The reranging procedure, however, created considerable oscillation (hysteresis) in the springs of the meter resulting in erratic instrument drift and making it difficult, if not impossible, to measure gravity accurately at the microGal-level for several hours after the procedure. During this period of erratic instrument drift, the gravity meter was used to determine the relative differences between stations on the periphery of the injection area and Quartz Hill. Once drift had subsided, the cross and long levels on the meter (fig. 22) and meter sensitivity were field checked. If the cross level is not adjusted correctly, the meter will not measure the full force of gravity, and if the sensitivity is set too low, valuable time will be wasted waiting for the meter to find null. All gravity meter operators should know how to perform these checks and adjustments as described by the LaCoste and Romberg (1997) instruction manual. We suggest one additional check that was not included in the manual; this step pertains to the electrostatic nulling device. If the device is to be used, the sensitivity checks should be done with the nulling device enabled, but not operating. There are two switches on the nulling device, one labeled “E” (enable) and “D” (disable) and the other labeled “R” (run) and “O” (off); they should be set to E and O positions.

Once the cross and long levels and meter sensitivity have been checked, a preliminary survey should be made to determine values of the nulling dial for all stations. This is done first by leveling the meter for any given station and then by releasing the internal beam of the gravity meter. Next, turn on the reading lamp and look into the microscope eyepiece; the shadow of the beam will be visible on one side or the other of the reading line. If the beam is to the left of the reading line, turn the nulling dial clockwise; if the beam is to the right of the reading line, turn the nulling dial counterclockwise. The nulling dial should be turned smoothly in full revolution increments, always ending at zero, until the beam shadow reaches the reading line. Always turn off the incandescent reading lamp as soon as possible because the excess heat can induce mechanical hysteresis in the springs and levers from thermal expansion. Once a dial value is determined for a station, this value should be used for all subsequent measurements at that station. This eliminates introduction of screw calibration errors (circular error

in the machining of the screw) into the measured difference for a station from one survey to another. When two adjacent stations had similar dial values, we used an average dial value for both. This precaution eliminates the introduction of screw calibration errors into the measured difference between the adjacent stations. This “quiet” operation uses only the electrostatic nulling device to measure gravity between the adjacent stations. This operation is termed quiet because the noise of spring hysteresis from turning the nulling dial is avoided.

APPENDIX B. DISCUSSION ON MAKING A MICROGRAVITY MEASUREMENT

Upon reaching the station to be measured, the carrying case should be gently set on the ground within 2 ft of the station. To minimize possible jarring motions, the meter operator should kneel on foam knee pads while moving the meter from its carrying case to the gravity station. Great care must be taken when setting the meter on the station. The operator should cradle the meter with both hands and then, with elbows on the ground, set the reference leg into the central divot of the gravity station. The remaining two legs should be positioned with great care. If the operator is able to hear the meter legs touching the station, insufficient care was taken in handling the instrument.

Once the meter is nestled onto the bronze tablets, it can be leveled. The reference leg should have a locking nut on it; the leveling of the meter is done using the remaining two legs. The quickest method of leveling the meter is to level the cross level first and then the long level. After the meter is level, the internal beam can be released by turning the arrestment knob counterclockwise. Extreme care must be taken once the beam is released. Accidentally bumping the meter can severely damage internal parts, rendering the meter inoperable. If the preset dial reading is correct, the beam should approach the null position within 30 seconds. The null position can be observed on the electronic galvanometer (voltage indicator) when the needle is centered or by viewing the beam shadow through the microscope eyepiece. Once the needle is centered or the beam shadow is very near the reading line, the electrostatic nulling device can be enabled and then turned on. First toggle the switch labeled E and D to the enable (E) position and then toggle the switch labeled R and O to the run (R) position. At this point, the station identifier, the dial counter reading, the time when the nulling device was turned on, and any atmospheric and (or) anthropogenic disturbances should be recorded.

The nulling device needs a 4- to 7-minute waiting period after activation to allow spring hysteresis to dissipate and to establish a constant rate of change in the digital output. During the waiting period, the data logger can be turned on. Starting a few minutes after the nulling device is activated, the averaged (for 20 measurements) filtered gravity output (in millivolts) and standard deviation (in millivolts) should be recorded manually at 1-minute intervals even though they also may be recorded digitally. This allows the gravity meter operator to monitor the trend, or the lack thereof, of the output. For this study, the gravity meter was allowed to stabilize for 5 minutes before each measurement. Once a consistent rate of change (1 to 5 millivolts per minute) and an acceptable standard deviation (1 millivolt or less) are recorded, the operator can be confident that the measurement is good. At this point, the electrostatic nulling device can be turned off, but left enabled. The data logger should also be turned off. Before the beam is clamped down to prevent it from bouncing during transport, the dial counter should be set for the next station. When turning the nulling dial, turns should be made smoothly without jerking the meter. Furthermore, the desired dial counter reading should always be obtained by turning the nulling dial in a clockwise direction. If the desired value is less than the present value, the operator will turn the nulling dial counterclockwise past the desired value at least one full revolution, then clockwise until reaching the desired value, being careful not to go past that value. If the desired value is inadvertently passed, even slightly, the nulling dial should be turned counterclockwise again one full turn and then turned clockwise until reaching the desired value. Care should be taken the first time, because the back and forth turning of the dial introduces unnecessary noise (spring hysteresis) into the next measurement. Once the dial is set, the internal beam can be clamped down.

Clamping the beam before moving the meter is absolutely critical. Clamping the beam also reduces the random oscillations induced by turning the nulling dial. Once the beam is clamped, the meter can safely be moved back to the carrying case and on to the next station. If gravity stations are within walking distance, the meter should be hand carried between stations. If a motorized vehicle is to be used, the driver should exercise care to avoid sudden stops, potholes, and uneven sections of the road. The best solution for a smooth ride is to have a person hold the meter while in transit.

APPENDIX C. DISCUSSION ON SOURCES OF MICROGRAVITY SURVEY ERRORS

Nonlinear instrument drift can be a major source of microgravity survey error. One of the primary causes of nonlinear drift is jostling the meter during transport. The effects of jostling, however, can be minimized by transporting the meter in a soft carrying case, by having someone hold the meter while in transit, and by using a smooth-riding vehicle. A soft carrying case is especially critical because it reduces the effects of bumps and vibrations on the meter during transit between stations. The gravity meter used for this study was transported in a soft carrying case constructed of open-cell foam. The case also was used to organize the data logger, data storage module, keyboard/display, two 12-V, 6.5 Amp-Hour (AHr) batteries, and an electronic barometer so that packing and unpacking time was minimized between measurements. The extra weight (19 pounds) of these accessories, plus the 7.7-pound weight of the gravity meter, also helped soften the jolts and high-frequency vibrations encountered during transit.

Another source of nonlinear drift is variation in the temperature of the gravity meter. Although the gravity meter has a thermostat and an internal heating element, temperature variations can occur during a survey. Several steps can be taken to minimize the variations; they include (1) protecting the meter from direct sunlight (For this study, the meter was shaded either by the operator or by a white cardboard box.); (2) not leaving the meter in a vehicle where ambient temperature can rise quickly; (3) using predetermined dial values for each station thereby eliminating use of the meter's incandescent reading lamp, which is a considerable source of heat; (4) turning on the meter and the nulling device several days before a survey to allow thermal stabilization of the meter; and (5) leaving the electronic nulling device enabled (E) for the duration of the survey.

Barometric effects also are a source of nonlinear drift. Gravity meters normally are sealed and protected from barometric effects by an O-ring; but on older meters, or meters that have not been factory serviced for at least 10 years, the O-ring can be cracked. Despite a buoyancy compensator in the beam mechanism, a failing O-ring can cause differential barometric loading on the beam mass and result in nonlinear instrument drift over time. For this study, each survey loop, which began and ended at the GR reference station and was completed two times, was restricted to three or four stations to limit measurement time to 2 to 3 hours. Minimizing the time spent on each loop minimized the effects of nonlinear drift owing to temporal changes in

barometric pressure. Survey loops that required more than 3 hours generally produced unacceptable drift rates. Surveys loops done during the passage of a weather front and an abrupt change in barometric pressure also usually produced unacceptable drift rates.

Wind can produce unwanted effects on a gravity meter. As the meter is buffeted by the wind, it can be tipped out of plumb, reducing the gravity measurement. Wind also can cause the beam and springs to oscillate, introducing noise into the measurement. During this study a white cardboard box was used to shield the meter from the wind and the sun. Two of the box flaps were cut off so that handling the box was easier. Great care was taken not to bump the meter while covering or uncovering it. The remaining two flaps were weighted to prevent the box from moving. A small window was cut in the top of the box so that the meter levels, reading galvanometer, and counter dial could be viewed when the meter was covered.

Earthquakes, even distant large earthquakes, can render a gravity meter inoperable for hours or even days. If the galvanometer needle and levels behave erratically (swinging wildly from side to side), the gravity meter operator should suspect seismicity as the cause. To confirm or dismiss seismicity as a cause, the operator can call the U.S. Geological Survey National Earthquake Information Center (NEIC) in Golden, Colorado, at (800) 525-7848. The epicenters and magnitudes of earthquakes are determined rapidly by the USGS and information on an earthquake is quickly available to the general public.

On November 6, 1996, during a microgravity survey for this study, the needle of the galvanometer was observed swinging erratically. A call was made to the NEIC which confirmed an earthquake of a magnitude greater than 7 in the Bonin Islands 375 mi south of Tokyo, Japan. Resonance ringing was observed for nearly 1 hour. The survey loop that was in progress at the time of the earthquake was abandoned, and subsequent survey loops that same day produced unacceptable results. On the following day, the meter performed normally.

Solar flare activity can affect meter readings. Bursts of solar radiation produced by solar flare activity can interfere with the electrostatic nulling device. While these effects are not immediately obvious to the operator, the effects become clear when the field data are reduced (solid earth tides removed). Significant solar flare activity was thought to be the cause of unacceptable instrument drift for two survey loops conducted on April 9, 1997. Survey loops on the following day were successful.

Electromagnetic fields from radio station transmitters and two-way field radios can affect the

electrostatic nulling device and (or) the galvanometer. Two-way radios should be turned off while surveying. Surveying near powerful radio transmitters should be avoided altogether. The effects of frequent, low-flying military aircraft over a study area during surveys are unknown.

Underground utilities including buried phone lines, high-voltage alternating current (AC) power lines, and water mains can adversely affect the

operation of the meter. To avoid these potential sources of survey error, locations of underground utilities should be identified and gravity stations should be constructed as far away from them as possible. Within the contiguous United States, a phone call to Underground Service Alert will notify all the pertinent utilities. The utility companies will then locate and mark their buried lines and (or) pipes within the area in question.

Tables 9–11 Follow this page

Table 9. Physical properties and major-ion concentrations in water samples collected during cycles 1 and 2 of the injection, storage, and

[Sample collection sites: ground-water sites are identified by local well name (see table 1 for well information), and imported surface-water sites]

Water chemistry data were compiled from 15 active production wells from late March 1995 through mid-May 1995, prior to the beginning of the study.

Department of Agricultural Commissioner and Weights and Measures; USGS, U.S. Geological Survey. NO₃, nitrate, CaCO₃, calcium carbonate.

milligram per liter. (L), measured in laboratory. <, less than; na, not applicable; —, no data]

Sample collection site (local well name)	Sampling date	Day of cycle phase	Collected by/ analyzed by	Specific conductance ($\mu\text{S}/\text{cm}$)	pH (standard units)	Tempera-ture, water (°C)	Apparent color, unfiltered (units)	Odor threshold at 60°C (TON)	Turbidity (NTU)	Dissolved oxygen (mg/L)
Cycle 1 pre-injection										
4-9	03-24-95	na	LAC/LAC	265 (L)	7.9 (L)	—	0	0	0.7 (L)	—
4-17	03-24-95	na	LAC/LAC	521 (L)	8.3 (L)	—	0	0	.9 (L)	—
4-26	03-24-95	na	LAC/LAC	252 (L)	8.0 (L)	—	0	0	.7 (L)	—
4-33	03-27-95	na	LAC/LAC	265 (L)	7.8 (L)	—	< 5	0	3.3 (L)	—
4-42	03-27-95	na	LAC/LAC	629 (L)	8.4 (L)	—	0	0	3.7 (L)	—
4-5	03-27-95	na	LAC/LAC	246 (L)	7.6 (L)	—	0	0	1.8 (L)	—
4-12	04-11-95	na	LAC/LAC	257 (L)	8.0 (L)	—	0	0	.4 (L)	—
4-25	04-11-95	na	LAC/LAC	252 (L)	8.0 (L)	—	0	0	1.7 (L)	—
4-30	04-11-95	na	LAC/LAC	406 (L)	8.3 (L)	—	0	0	.2 (L)	—
4-32	04-11-95	na	LAC/LAC	328 (L)	8.3 (L)	—	0	0	.3 (L)	—
4-34	04-11-95	na	LAC/LAC	388 (L)	8.2 (L)	—	0	0	.2 (L)	—
4-37	04-11-95	na	LAC/LAC	309 (L)	8.1 (L)	—	0	0	.2 (L)	—
4-38	04-11-95	na	LAC/LAC	263 (L)	8.0 (L)	—	0	0	.2 (L)	—
4-43	05-09-95	na	LAC/LAC	1,030 (L)	7.9 (L)	—	0	0	.4 (L)	—
4-44	05-09-95	na	LAC/LAC	932 (L)	7.6 (L)	—	0	0	.1 (L)	—
4-13	10-16-95	na	LAC/LAC	327 (L)	8.2 (L)	—	0	0	1.4 (L)	—
4-29	10-16-95	na	LAC/LAC	390 (L)	8.0 (L)	—	0	0	.3 (L)	—
Cycle 1 injection										
4-32(AVEK)	04-09-96	2	AVEK/AVEK	345 (L)	6.9 (L)	—	—	—	—	—
4-32(AVEK)	04-11-96	4	LAC/LAC	324	6.9	19.0	—	—	0.7	—
4-32(AVEK)	04-11-96	4	AVEK/AVEK	327 (L)	6.9 (L)	—	—	—	—	—
4-32(AVEK)	04-18-96	11	AVEK/AVEK	370 (L)	6.7 (L)	—	—	—	—	—
4-32(AVEK)	04-19-96	12	LAC/LAC	376	6.9	18.0	—	—	.7	—
4-32(AVEK)	04-25-96	18	AVEK/AVEK	410 (L)	6.9 (L)	—	—	—	—	—
4-32(AVEK)	04-26-96	19	LAC/LAC	413	7.3	18.0	—	—	.2	—
4-32(AVEK)	05-02-96	25	LAC/LAC	480	7.2	21.0	—	—	.3	—
4-32(AVEK)	05-02-96	25	AVEK/AVEK	480 (L)	7.1 (L)	—	—	—	—	—
Cycle 1 storage										
4-13	05-15-96	10	LAC/LAC	532 (L)	8.4 (L)	—	< 5	0	5.1 (L)	—
4-29	05-15-96	10	LAC/LAC	472 (L)	8.0 (L)	—	0	0	1.7 (L)	—
4-30	05-15-96	10	LAC/LAC	427 (L)	7.7 (L)	—	0	0	.5 (L)	—
4-32	05-15-96	10	LAC/LAC	473 (L)	7.2 (L)	—	0	0	6.2 (L)	—
4-33	05-15-96	10	LAC/LAC	243 (L)	7.8 (L)	—	0	0	1.5 (L)	—
4-34	05-15-96	10	LAC/LAC	484 (L)	7.3 (L)	—	0	0	4.3 (L)	—
4-42	05-15-96	10	LAC/LAC	618 (L)	8.5 (L)	—	< 5	0	5.2 (L)	—
4-43	05-15-96	10	LAC/LAC	1,030 (L)	7.8 (L)	—	0	0	.5 (L)	—
4-44	05-15-96	10	LAC/LAC	928 (L)	7.8 (L)	—	0	0	.7 (L)	—
4-13	05-17-96	12	LAC/LAC	536	8.5	30.0	—	—	2.7	—
4-32	05-17-96	12	LAC/LAC	474	6.7	25.0	—	—	15	—
4-32	05-17-96	12	AVEK/AVEK	480 (L)	7.0 (L)	—	—	—	—	—
4-33	05-17-96	12	LAC/LAC	250	8.1	27.0	—	—	4.5	—
4-34	05-17-96	12	LAC/LAC	479	6.9	24.0	—	—	8.5	—
4-42	05-17-96	12	LAC/LAC	616	8.6	31.0	—	—	5.2	—

recovery study at Lancaster, Antelope Valley, California, March 1995 through January 1998

(the injection wells) are identified by the local well name and the name of the water-importing agency (AVEK, Antelope Valley–East Kern Water Agency). Water in AVEK wells 4-32 and 4-34 was sampled as the water was injected during cycles 1 and 2. Collected by/analyzed by: LAC, Los Angeles County TON, threshold odor number; NTU, nephelometric turbidity unit; $\mu\text{S}/\text{cm}$, microsiemens per centimeter at 25 degrees Celsius; °C, degrees Celsius; mg/L,

Hardness, total (mg/L as CaCO_3)	Calcium, dissolved (mg/L)	Magnesium, dissolved (mg/L)	Sodium, dissolved (mg/L)	Potassium, dissolved (mg/L)	Alkalinity, total (mg/L as CaCO_3)	Sulfate, dissolved (mg/L)	Chloride, dissolved (mg/L)	Fluoride, dissolved (mg/L)	Dissolved, solids (mg/L)	Methylene blue active substance (mg/L)	Nitrate (mg/L as NO_3)
Cycle 1 pre-injection											
15	4.0	1.2	52	0.9	128 (L)	16	4.0	0.5	176	0.09	0.36
40	16	<.1	98	2	118 (L)	62	74	.7	314	.05	2.3
55	18	2.4	34	1	118 (L)	17	6.0	.2	156	.05	.30
60	22	1.2	31	1	112 (L)	22	11	.2	158	<.05	2.2
22	8.0	.5	120	2	139 (L)	70	72	.9	374	—	1.3
60	20	2.4	29	1	112 (L)	16	6.0	.3	150	.11	2.4
50	20	<.1	32	1	123 (L)	14	3.2	.3	156	<.05	1.2
55	18	2.4	31	1	118 (L)	14	3.2	.3	154	<.05	.93
68	22	3.2	60	1	123 (L)	51	25	.4	248	<.05	1.0
45	14	1.2	53	1	118 (L)	28	14	.3	198	<.05	3.7
65	21	3.2	59	1	144 (L)	38	21	.2	238	<.05	3.3
40	8.0	4.9	52	1	139 (L)	23	8.1	.4	186	<.05	2.0
60	20	2.4	32	1	128 (L)	15	4.1	.3	160	<.05	.71
230	88	2.4	120	4	118 (L)	280	96	.3	630	<.05	3.0
220	84	2.4	110	4	123 (L)	200	96	.3	574	<.05	7.6
39	12	2.2	55	1	112 (L)	28	22	.4	196	<.05	.80
55	18	2.4	68	2	161 (L)	40	17	.5	232	<.05	1.4
Cycle 1 injection											
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	40	—	188	—	—
—	—	—	—	—	—	—	37	—	—	—	—
—	—	—	—	—	—	—	45	—	—	—	—
—	—	—	—	—	—	—	42	—	218	—	—
—	—	—	—	—	—	—	48	—	—	—	—
—	—	—	—	—	—	—	50	—	247	—	—
—	—	—	—	—	—	—	61	—	254	—	—
—	—	—	—	—	—	—	67	—	—	—	—
Cycle 1 storage											
35	11	1.7	98	2	112 (L)	56	59	0.6	326	<0.05	0.87
70	26	1.2	76	2	134 (L)	60	30	.3	300	<.05	2.3
70	25	1.9	65	2	132 (L)	54	24	.3	270	<.05	1.8
100	24	9.7	52	3	48 (L)	70	65	<.1	280	<.05	4.3
60	20	2.4	29	1	96 (L)	20	8.9	.3	160	<.05	2.4
110	22	13	53	4	56 (L)	69	71	<.1	290	<.05	4.2
20	6.4	1.0	110	2	136 (L)	64	60	1.3	380	<.05	2.8
230	86	3.6	120	5	100 (L)	190	150	.3	662	<.05	5.0
220	88	.2	110	4	106 (L)	200	110	.3	610	<.05	5.6
—	—	—	—	—	—	—	60	—	312	—	—
—	—	—	—	—	—	—	63	—	266	—	—
—	—	—	—	—	—	—	63	—	—	—	—
—	—	—	—	—	—	—	8.5	—	160	—	—
—	—	—	—	—	—	—	64	—	262	—	—
—	—	—	—	—	—	—	61	—	366	—	—

Table 9. Physical properties and major-ion concentrations in water samples collected during cycles 1 and 2 of the injection, storage, and

Sample collection site (local well name)	Sampling date	Day of cycle phase	Collected by/ analyzed by	Specific conductance ($\mu\text{S}/\text{cm}$)	pH (standard units)	Temper- ature, water ($^{\circ}\text{C}$)	Apparent color, unfiltered (units)	Odor threshold at 60°C (TON)	Turbidity (NTU)	Dissolved oxygen (mg/L)
Cycle 1 recovery										
4-32	05-21-96	1	AVEK/AVEK	463 (L)	7.0 (L)	—	—	—	—	—
4-34	05-21-96	1	AVEK/AVEK	497 (L)	10.1 (L)	—	—	—	—	—
4-13	05-22-96	2	LAC/LAC	530	8.6	28.0	—	—	1.7	—
4-32	05-22-96	2	LAC/LAC	497	7.1	21.0	—	—	1.6	—
4-33	05-22-96	2	LAC/LAC	263	8.2	24.0	—	—	.7	—
4-34	05-22-96	2	LAC/LAC	476	7.3	21.0	—	—	2.3	—
4-42	05-22-96	2	LAC/LAC	616	8.8	30.0	—	—	1.0	—
4-32	05-23-96	3	AVEK/AVEK	480 (L)	7.0 (L)	—	—	—	—	—
4-34	05-23-96	3	AVEK/AVEK	460 (L)	7.2 (L)	—	—	—	—	—
4-13	05-24-96	4	LAC/LAC	424	8.3	27.0	—	—	.6	—
4-32	05-24-96	4	LAC/LAC	456	6.9	21.0	—	—	1.1	—
4-33	05-24-96	4	LAC/LAC	279	8.0	24.0	—	—	.6	—
4-34	05-24-96	4	LAC/LAC	445	7.2	21.0	—	—	1.2	—
4-42	05-24-96	4	LAC/LAC	595	8.7	29.0	—	—	.3	—
4-13	05-28-96	8	LAC/LAC	382	8.3	27.0	—	—	.2	—
4-32	05-28-96	8	LAC/LAC	398	7.1	22.0	—	—	.8	—
4-33	05-28-96	8	LAC/LAC	271	8.2	23.0	—	—	.7	—
4-34	05-28-96	8	LAC/LAC	401	7.5	22.0	—	—	1.0	—
4-42	05-28-96	8	LAC/LAC	558	8.6	29.0	—	—	.2	—
4-13	05-30-96	10	LAC/LAC	393	8.5	27.0	—	—	.3	—
4-32	05-30-96	10	LAC/LAC	407	7.6	23.0	—	—	1.0	—
4-32	05-30-96	10	AVEK/AVEK	400 (L)	7.2 (L)	—	—	—	—	—
4-33	05-30-96	10	LAC/LAC	287	8.5	24.0	—	—	.3	—
4-34	05-30-96	10	LAC/LAC	414	7.9	22.0	—	—	.8	—
4-34	05-30-96	10	AVEK/AVEK	400 (L)	7.6 (L)	—	—	—	—	—
4-42	05-30-96	10	LAC/LAC	563	8.8	29.0	—	—	.2	—
4-13	05-31-96	11	LAC/LAC	377	8.2	27.0	—	—	.6	—
4-32	05-31-96	11	LAC/LAC	390	6.8	23.0	—	—	.8	—
4-33	05-31-96	11	LAC/LAC	279	8.3	25.0	—	—	.6	—
4-34	05-31-96	11	LAC/LAC	396	7.9	23.0	—	—	.5	—
4-42	05-31-96	11	LAC/LAC	552	8.5	29.0	—	—	.5	—
4-13	06-03-96	14	LAC/LAC	366	8.5	27.0	—	—	.2	—
4-32	06-03-96	14	LAC/LAC	353	7.4	23.0	—	—	.6	—
4-33	06-03-96	14	LAC/LAC	270	8.4	24.0	—	—	.2	—
4-34	06-03-96	14	LAC/LAC	380	8.0	23.0	—	—	.5	—
4-42	06-03-96	14	LAC/LAC	528	8.7	29.0	—	—	.2	—
4-13	06-04-96	15	LAC/LAC	362	8.4	27.0	—	—	.2	—
4-32	06-04-96	15	LAC/LAC	340	7.7	24.0	—	—	.6	—
4-33	06-04-96	15	LAC/LAC	262	8.4	24.0	—	—	.2	—
4-34	06-04-96	15	LAC/LAC	364	8.0	24.0	—	—	.3	—
4-42	06-04-96	15	LAC/LAC	512	8.7	29.0	—	—	.2	—
4-13	06-06-96	17	LAC/LAC	378	8.5	26.0	—	—	.2	—
4-32	06-06-96	17	LAC/LAC	358	7.9	24.5	—	—	.6	—

recovery study at Lancaster, Antelope Valley, California, March 1995 through January 1998—Continued

Hardness, total (mg/L as CaCO_3)	Calcium, dissolved (mg/L)	Magne- sium, dissolved (mg/L)	Sodium, dissolved (mg/L)	Potassium, dissolved (mg/L)	Alkalinity, total (mg/L as CaCO_3)	Sulfate, dissolved (mg/L)	Chloride, dissolved (mg/L)	Fluoride, dissolved (mg/L)	Dissolved, solids (mg/L)	Methylene blue active substance (mg/L)	Nitrate (mg/L as NO_3)
Cycle 1 recovery											
—	—	—	—	—	—	—	59	—	—	—	—
—	—	—	—	—	—	—	67	—	—	—	—
—	—	—	—	—	—	—	66	—	308	—	—
—	—	—	—	—	—	—	80	—	294	—	—
—	—	—	—	—	—	—	12	—	164	—	—
—	—	—	—	—	—	—	68	—	274	—	—
—	—	—	—	—	—	—	71	—	366	—	—
—	—	—	—	—	—	—	67	—	—	—	—
—	—	—	—	—	—	—	59	—	—	—	—
—	—	—	—	—	—	—	43	—	258	—	—
—	—	—	—	—	—	—	68	—	278	—	—
—	—	—	—	—	—	—	15	—	180	—	—
—	—	—	—	—	—	—	58	—	256	—	—
—	—	—	—	—	—	—	66	—	366	—	—
—	—	—	—	—	—	—	38	—	244	—	—
—	—	—	—	—	—	—	50	—	242	—	—
—	—	—	—	—	—	—	14	—	186	—	—
—	—	—	—	—	—	—	48	—	248	—	—
—	—	—	—	—	—	—	62	—	358	—	—
—	—	—	—	—	—	—	35	—	236	—	—
—	—	—	—	—	—	—	46	—	238	—	—
—	—	—	—	—	—	—	44	—	—	—	—
—	—	—	—	—	—	—	13	—	186	—	—
—	—	—	—	—	—	—	41	—	242	—	—
—	—	—	—	—	—	—	39	—	—	—	—
—	—	—	—	—	—	—	63	—	344	—	—
—	—	—	—	—	—	—	32	—	240	—	—
—	—	—	—	—	—	—	45	—	234	—	—
—	—	—	—	—	—	—	13	—	184	—	—
—	—	—	—	—	—	—	41	—	240	—	—
—	—	—	—	—	—	—	59	—	338	—	—
—	—	—	—	—	—	—	32	—	232	—	—
—	—	—	—	—	—	—	39	—	212	—	—
—	—	—	—	—	—	—	12	—	172	—	—
—	—	—	—	—	—	—	38	—	230	—	—
—	—	—	—	—	—	—	55	—	310	—	—
—	—	—	—	—	—	—	31	—	242	—	—
—	—	—	—	—	—	—	37	—	220	—	—
—	—	—	—	—	—	—	13	—	190	—	—
—	—	—	—	—	—	—	36	—	242	—	—
—	—	—	—	—	—	—	51	—	334	—	—
—	—	—	—	—	—	—	31	—	250	—	—
—	—	—	—	—	—	—	30	—	228	—	—

Table 9. Physical properties and major-ion concentrations in water samples collected during cycles 1 and 2 of the injection, storage, and

Sample collection site (local well name)	Sampling date	Day of cycle phase	Collected by/ analyzed by	Specific conductance ($\mu\text{S}/\text{cm}$)	pH (standard units)	Tempera- ture, water (°C)	Apparent color, unfiltered (units)	Odor threshold at 60°C (TON)	Turbidity (NTU)	Dissolved oxygen (mg/L)
Cycle 1 recovery—Continued										
4-33	06-06-96	17	LAC/LAC	283	8.5	24.0	—	—	0.2	—
4-34	06-06-96	17	LAC/LAC	403	8.0	24.5	—	—	.8	—
4-42	06-06-96	17	LAC/LAC	520	8.7	28.0	—	—	.2	—
4-13	06-07-96	18	LAC/LAC	360	8.5	26.0	—	—	.2	—
4-32	06-07-96	18	LAC/LAC	334	7.8	24.0	—	—	.3	—
4-32	06-07-96	18	AVEK/AVEK	340 (L)	7.6 (L)	—	—	—	—	—
4-33	06-07-96	18	LAC/LAC	269	8.4	24.0	—	—	.2	—
4-34	06-07-96	18	LAC/LAC	383	7.8	24.0	—	—	.3	—
4-34	06-07-96	18	AVEK/AVEK	390 (L)	7.8 (L)	—	—	—	—	—
4-42	06-07-96	18	LAC/LAC	506	8.7	29.0	—	—	.1	—
4-13	06-08-96	19	LAC/LAC	356	8.5	27.0	—	—	.2	—
4-32	06-08-96	19	LAC/LAC	331	7.9	24.0	—	—	.4	—
4-33	06-08-96	19	LAC/LAC	267	8.3	25.0	—	—	.3	—
4-34	06-08-96	19	LAC/LAC	380	8.0	24.0	—	—	.3	—
4-42	06-08-96	19	LAC/LAC	501	8.7	28.0	—	—	.4	—
4-13	06-09-96	20	LAC/LAC	369	8.5	26.5	—	—	.2	—
4-32	06-09-96	20	LAC/LAC	339	8.0	24.0	—	—	.4	—
4-33	06-09-96	20	LAC/LAC	279	8.5	24.0	—	—	.3	—
4-34	06-09-96	20	LAC/LAC	397	8.0	24.0	—	—	.4	—
4-42	06-09-96	20	LAC/LAC	502	8.7	27.5	—	—	.2	—
4-13	06-10-96	21	LAC/LAC	367	7.9	27.0	—	—	.2	—
4-32	06-10-96	21	LAC/LAC	338	7.9	25.0	—	—	.4	—
4-33	06-10-96	21	LAC/LAC	277	8.4	25.0	—	—	.2	—
4-34	06-10-96	21	LAC/LAC	396	8.0	24.0	—	—	.4	—
4-42	06-10-96	21	LAC/LAC	506	8.3	29.0	—	—	.2	—
4-13	06-11-96	22	LAC/LAC	365	8.3	27.0	—	—	.2	—
4-32	06-11-96	22	LAC/LAC	341	7.6	24.0	—	—	.4	—
4-33	06-11-96	22	LAC/LAC	276	8.3	25.0	—	—	.4	—
4-34	06-11-96	22	LAC/LAC	396	8.0	24.0	—	—	.3	—
4-42	06-11-96	22	LAC/LAC	503	8.6	29.0	—	—	.2	—
4-13	06-12-96	23	LAC/LAC	341	8.2	26.0	—	—	.3	—
4-32	06-12-96	23	LAC/LAC	310	8.0	24.0	—	—	.3	—
4-33	06-12-96	23	LAC/LAC	256	8.3	24.0	—	—	.2	—
4-34	06-12-96	23	LAC/LAC	372	8.0	24.0	—	—	.2	—
4-42	06-12-96	23	LAC/LAC	482	8.5	27.0	—	—	.2	—
4-13	06-13-96	24	LAC/LAC	341	8.3	30.0	—	—	.2	—
4-32	06-13-96	24	LAC/LAC	309	8.1	29.0	—	—	.5	—
4-32	06-13-96	24	AVEK/AVEK	320 (L)	7.8 (L)	—	—	—	—	—
4-33	06-13-96	24	LAC/LAC	258	8.3	29.0	—	—	.3	—
4-34	06-13-96	24	LAC/LAC	374	8.0	27.0	—	—	.4	—
4-34	06-13-96	24	AVEK/AVEK	380 (L)	8.0 (L)	—	—	—	—	—
4-42	06-13-96	24	LAC/LAC	483	8.6	31.0	—	—	.5	—
4-13	06-14-96	25	LAC/LAC	358	8.4	30.0	—	—	.4	—
4-32	06-14-96	25	LAC/LAC	326	8.1	28.0	—	—	.3	—
4-33	06-14-96	25	LAC/LAC	277	8.4	28.0	—	—	.1	—

recovery study at Lancaster, Antelope Valley, California, March 1995 through January 1998—Continued

Hardness, total (mg/L as CaCO_3)	Calcium, dissolved (mg/L)	Magnesium, dissolved (mg/L)	Sodium, dissolved (mg/L)	Potassium, dissolved (mg/L)	Alkalinity, total (mg/L as CaCO_3)	Sulfate, dissolved (mg/L)	Chloride, dissolved (mg/L)	Fluoride, dissolved (mg/L)	Dissolved, solids (mg/L)	Methylene blue active substance (mg/L)	Nitrate (mg/L as NO_3)
Cycle 1 recovery—Continued											
—	—	—	—	—	—	—	12	—	194	—	—
—	—	—	—	—	—	—	34	—	252	—	—
—	—	—	—	—	—	—	50	—	326	—	—
—	—	—	—	—	—	—	25	—	232	—	—
—	—	—	—	—	—	—	24	—	200	—	—
—	—	—	—	—	—	—	35	—	—	—	—
—	—	—	—	—	—	—	8.0	—	184	—	—
—	—	—	—	—	—	—	28	—	230	—	—
—	—	—	—	—	—	—	29	—	—	—	—
—	—	—	—	—	—	—	47	—	524	—	—
—	—	—	—	—	—	—	25	—	228	—	—
—	—	—	—	—	—	—	22	—	214	—	—
—	—	—	—	—	—	—	8.4	—	184	—	—
—	—	—	—	—	—	—	27	—	234	—	—
—	—	—	—	—	—	—	46	—	312	—	—
—	—	—	—	—	—	—	24	—	230	—	—
—	—	—	—	—	—	—	23	—	208	—	—
—	—	—	—	—	—	—	8.4	—	180	—	—
—	—	—	—	—	—	—	26	—	240	—	—
—	—	—	—	—	—	—	43	—	318	—	—
—	—	—	—	—	—	—	24	—	236	—	—
—	—	—	—	—	—	—	18	—	204	—	—
—	—	—	—	—	—	—	7.9	—	178	—	—
—	—	—	—	—	—	—	24	—	238	—	—
—	—	—	—	—	—	—	43	—	308	—	—
—	—	—	—	—	—	—	23	—	240	—	—
—	—	—	—	—	—	—	17	—	200	—	—
—	—	—	—	—	—	—	7.8	—	182	—	—
—	—	—	—	—	—	—	25	—	238	—	—
—	—	—	—	—	—	—	56	—	310	—	—
—	—	—	—	—	—	—	23	—	234	—	—
—	—	—	—	—	—	—	17	—	202	—	—
—	—	—	—	—	—	—	7.5	—	176	—	—
—	—	—	—	—	—	—	23	—	232	—	—
—	—	—	—	—	—	—	42	—	300	—	—
—	—	—	—	—	—	—	24	—	238	—	—
—	—	—	—	—	—	—	16	—	206	—	—
—	—	—	—	—	—	—	17	—	—	—	—
—	—	—	—	—	—	—	7.6	—	196	—	—
—	—	—	—	—	—	—	23	—	240	—	—
—	—	—	—	—	—	—	26	—	—	—	—
—	—	—	—	—	—	—	42	—	326	—	—
—	—	—	—	—	—	—	24	—	228	—	—
—	—	—	—	—	—	—	15	—	208	—	—
—	—	—	—	—	—	—	7.5	—	188	—	—

Table 9. Physical properties and major-ion concentrations in water samples collected during cycles 1 and 2 of the injection, storage, and

Sample collection site (local well name)	Sampling date	Day of cycle phase	Collected by/ analyzed by	Specific conductance ($\mu\text{S}/\text{cm}$)	pH (standard units)	Temperature, water (°C)	Apparent color, unfiltered (units)	Odor threshold at 60°C (TON)	Turbidity (NTU)	Dissolved oxygen (mg/L)
Cycle 1 recovery—Continued										
4-34	06-14-96	25	LAC/LAC	397	8.0	28.0	—	—	0.3	—
4-42	06-14-96	25	LAC/LAC	506	8.6	32.0	—	—	.4	—
4-13	06-15-96	26	LAC/LAC	351	8.6	26.0	—	—	.2	—
4-32	06-15-96	26	LAC/LAC	320	8.1	24.0	—	—	.3	—
4-33	06-15-96	26	LAC/LAC	271	8.5	24.0	—	—	.2	—
4-34	06-15-96	26	LAC/LAC	389	8.2	24.0	—	—	.3	—
4-42	06-15-96	26	LAC/LAC	481	8.7	27.0	—	—	.3	—
4-13	06-16-96	27	LAC/LAC	355	8.5	25.5	—	—	.2	—
4-32	06-16-96	27	LAC/LAC	327	8.1	24.0	—	—	.3	—
4-33	06-16-96	27	LAC/LAC	276	8.5	24.0	—	—	.2	—
4-34	06-16-96	27	LAC/LAC	397	8.1	24.0	—	—	.2	—
4-42	06-16-96	27	LAC/LAC	513	8.6	27.5	—	—	6.5	—
4-13	06-17-96	28	LAC/LAC	357	8.3	27.0	—	—	.2	—
4-32	06-17-96	28	LAC/LAC	324	7.7	24.0	—	—	.2	—
4-33	06-17-96	28	LAC/LAC	278	8.3	24.0	—	—	.1	—
4-34	06-17-96	28	LAC/LAC	398	8.1	24.0	—	—	.3	—
4-42	06-17-96	28	LAC/LAC	494	8.6	28.0	—	—	2.3	—
4-13	06-18-96	29	LAC/LAC	345	8.4	27.0	—	—	.2	—
4-32	06-18-96	29	LAC/LAC	304	8.0	25.0	—	—	.2	—
4-33	06-18-96	29	LAC/LAC	262	8.5	24.0	—	—	.2	—
4-34	06-18-96	29	LAC/LAC	374	8.1	24.0	—	—	.3	—
4-42	06-18-96	29	LAC/LAC	470	8.7	28.0	—	—	.4	—
4-13	06-19-96	30	LAC/LAC	340	8.5	26.0	—	—	.2	—
4-32	06-19-96	30	LAC/LAC	306	8.1	24.0	—	—	.2	—
4-33	06-19-96	30	LAC/LAC	262	8.5	25.0	—	—	.1	—
4-34	06-19-96	30	LAC/LAC	374	8.1	24.0	—	—	.2	—
4-42	06-19-96	30	LAC/LAC	470	8.6	28.0	—	—	.3	—
4-13	06-20-96	31	LAC/LAC	354	8.5	24.5	—	—	.1	—
4-32	06-20-96	31	LAC/LAC	322	8.2	23.0	—	—	.3	—
4-32	06-20-96	31	AVEK/AVEK	310 (L)	7.9 (L)	—	—	—	—	—
4-33	06-20-96	31	LAC/LAC	278	8.5	23.0	—	—	.2	—
4-34	06-20-96	31	LAC/LAC	399	8.3	22.0	—	—	.3	—
4-34	06-20-96	31	AVEK/AVEK	380 (L)	8.0 (L)	—	—	—	—	—
4-42	06-20-96	31	LAC/LAC	489	8.7	26.0	—	—	.3	—
4-13	06-21-96	32	LAC/LAC	353	8.6	26.0	—	—	.2	—
4-32	06-21-96	32	LAC/LAC	318	8.1	24.0	—	—	.2	—
4-33	06-21-96	32	LAC/LAC	275	8.6	24.0	—	—	.3	—
4-34	06-21-96	32	LAC/LAC	396	8.1	24.0	—	—	.3	—
4-42	06-21-96	32	LAC/LAC	492	8.7	28.0	—	—	1.3	—
4-13	06-22-96	33	LAC/LAC	357	8.6	25.0	—	—	.2	—
4-32	06-22-96	33	LAC/LAC	321	8.2	24.0	—	—	.3	—
4-33	06-22-96	33	LAC/LAC	280	8.6	23.5	—	—	.2	—
4-34	06-22-96	33	LAC/LAC	402	8.3	23.0	—	—	.3	—
4-42	06-22-96	33	LAC/LAC	494	8.7	26.0	—	—	.3	—
4-13	06-23-96	34	LAC/LAC	345	8.1	26.0	—	—	.4	—

recovery study at Lancaster, Antelope Valley, California, March 1995 through January 1998—Continued

Hardness, total (mg/L as CaCO_3)	Calcium, dissolved (mg/L)	Magnesium, dissolved (mg/L)	Sodium, dissolved (mg/L)	Potassium, dissolved (mg/L)	Alkalinity, total (mg/L as CaCO_3)	Sulfate, dissolved (mg/L)	Chloride, dissolved (mg/L)	Fluoride, dissolved (mg/L)	Dissolved, solids (mg/L)	Methylene blue active substance (mg/L)	Nitrate (mg/L as NO_3)
Cycle 1 recovery—Continued											
—	—	—	—	—	—	—	24	—	256	—	—
—	—	—	—	—	—	—	44	—	326	—	—
—	—	—	—	—	—	—	23	—	226	—	—
—	—	—	—	—	—	—	15	—	212	—	—
—	—	—	—	—	—	—	7.8	—	180	—	—
—	—	—	—	—	—	—	24	—	258	—	—
—	—	—	—	—	—	—	41	—	324	—	—
—	—	—	—	—	—	—	24	—	218	—	—
—	—	—	—	—	—	—	15	—	214	—	—
—	—	—	—	—	—	—	12	—	182	—	—
—	—	—	—	—	—	—	25	—	262	—	—
—	—	—	—	—	—	—	39	—	338	—	—
—	—	—	—	—	—	—	23	—	232	—	—
—	—	—	—	—	—	—	14	—	228	—	—
—	—	—	—	—	—	—	7.6	—	188	—	—
—	—	—	—	—	—	—	24	—	260	—	—
—	—	—	—	—	—	—	42	—	320	—	—
—	—	—	—	—	—	—	23	—	220	—	—
—	—	—	—	—	—	—	13	—	196	—	—
—	—	—	—	—	—	—	7.2	—	162	—	—
—	—	—	—	—	—	—	23	—	236	—	—
—	—	—	—	—	—	—	40	—	296	—	—
—	—	—	—	—	—	—	23	—	218	—	—
—	—	—	—	—	—	—	13	—	194	—	—
—	—	—	—	—	—	—	7.2	—	170	—	—
—	—	—	—	—	—	—	23	—	234	—	—
—	—	—	—	—	—	—	43	—	306	—	—
—	—	—	—	—	—	—	23	—	214	—	—
—	—	—	—	—	—	—	13	—	200	—	—
—	—	—	—	—	—	—	13	—	—	—	—
—	—	—	—	—	—	—	7.3	—	168	—	—
—	—	—	—	—	—	—	23	—	238	—	—
—	—	—	—	—	—	—	24	—	—	—	—
—	—	—	—	—	—	—	41	—	300	—	—
—	—	—	—	—	—	—	23	—	234	—	—
—	—	—	—	—	—	—	12	—	208	—	—
—	—	—	—	—	—	—	6.9	—	184	—	—
—	—	—	—	—	—	—	22	—	254	—	—
—	—	—	—	—	—	—	40	—	312	—	—
—	—	—	—	—	—	—	23	—	234	—	—
—	—	—	—	—	—	—	12	—	208	—	—
—	—	—	—	—	—	—	7.7	—	194	—	—
—	—	—	—	—	—	—	23	—	250	—	—
—	—	—	—	—	—	—	47	—	332	—	—
—	—	—	—	—	—	—	22	—	242	—	—

Table 9. Physical properties and major-ion concentrations in water samples collected during cycles 1 and 2 of the injection, storage, and

Sample collection site (local well name)	Sampling date	Day of cycle phase	Collected by/ analyzed by	Specific conductance ($\mu\text{S}/\text{cm}$)	pH (standard units)	Temperature, water ($^{\circ}\text{C}$)	Apparent color, unfiltered (units)	Odor threshold at 60°C (TON)	Turbidity (NTU)	Dissolved oxygen (mg/L)
Cycle 1 recovery—Continued										
4-32	06-23-96	34	LAC/LAC	310	7.6	25.0	—	—	0.3	—
4-33	06-23-96	34	LAC/LAC	266	8.0	25.0	—	—	.2	—
4-34	06-23-96	34	LAC/LAC	390	7.7	25.0	—	—	.3	—
4-42	06-23-96	34	LAC/LAC	476	8.2	28.0	—	—	.2	—
4-13	06-24-96	35	LAC/LAC	341	8.5	26.0	—	—	.2	—
4-32	06-24-96	35	LAC/LAC	305	8.2	25.0	—	—	.2	—
4-33	06-24-96	35	LAC/LAC	264	8.5	25.0	—	—	.2	—
4-34	06-24-96	35	LAC/LAC	379	8.2	25.0	—	—	.3	—
4-42	06-24-96	35	LAC/LAC	478	8.7	28.0	—	—	.3	—
4-13	06-25-96	36	LAC/LAC	333	8.5	24.0	—	—	.2	—
4-32	06-25-96	36	LAC/LAC	301	8.3	23.0	—	—	.4	—
4-33	06-25-96	36	LAC/LAC	260	8.4	23.0	—	—	.2	—
4-34	06-25-96	36	LAC/LAC	378	8.2	23.0	—	—	.5	—
4-42	06-25-96	36	LAC/LAC	468	8.7	26.5	—	—	.2	—
4-13	06-26-96	37	LAC/LAC	340	8.6	26.0	—	—	.2	—
4-32	06-26-96	37	LAC/LAC	303	8.3	25.0	—	—	.3	—
4-33	06-26-96	37	LAC/LAC	260	8.5	25.0	—	—	.2	—
4-34	06-26-96	37	LAC/LAC	383	8.3	25.0	—	—	.4	—
4-42	06-26-96	37	LAC/LAC	477	8.7	28.0	—	—	.3	—
4-13	06-27-96	38	LAC/LAC	349	8.5	24.5	—	—	.2	—
4-32	06-27-96	38	LAC/LAC	311	8.3	24.0	—	—	.2	—
4-32	06-27-96	38	AVEK/AVEK	310 (L)	8.0 (L)	—	—	—	—	—
4-33	06-27-96	38	LAC/LAC	268	8.5	23.5	—	—	.2	—
4-34	06-27-96	38	LAC/LAC	395	8.2	24.0	—	—	.3	—
4-34	06-27-96	38	AVEK/AVEK	390 (L)	8.0 (L)	—	—	—	—	—
4-42	06-27-96	38	LAC/LAC	478	8.7	26.5	—	—	.2	—
4-13	06-28-96	39	LAC/LAC	320	8.4	26.0	—	—	.2	—
4-32	06-28-96	39	LAC/LAC	288	8.0	24.0	—	—	.2	—
4-33	06-28-96	39	LAC/LAC	246	8.4	24.0	—	—	.2	—
4-34	06-28-96	39	LAC/LAC	365	8.1	24.0	—	—	.7	—
4-42	06-28-96	39	LAC/LAC	453	8.1	28.0	—	—	.2	—
4-13	06-29-96	40	LAC/LAC	326	8.0	26.0	—	—	.3	—
4-32	06-29-96	40	LAC/LAC	295	7.8	24.0	—	—	.6	—
4-33	06-29-96	40	LAC/LAC	253	8.1	24.0	—	—	.2	—
4-34	06-29-96	40	LAC/LAC	374	7.8	24.0	—	—	.8	—
4-42	06-29-96	40	LAC/LAC	480	8.3	29.0	—	—	.3	—
4-13	06-30-96	41	LAC/LAC	350	8.4	25.5	—	—	.2	—
4-32	06-30-96	41	LAC/LAC	317	8.3	24.5	—	—	.2	—
4-33	06-30-96	41	LAC/LAC	273	8.4	24.0	—	—	.2	—
4-34	06-30-96	41	LAC/LAC	405	8.2	24.5	—	—	.2	—
4-42	06-30-96	41	LAC/LAC	482	8.5	27.0	—	—	.2	—
4-13	07-01-96	42	LAC/LAC	350	8.5	26.0	—	—	.3	—
4-32	07-01-96	42	LAC/LAC	312	8.2	25.0	—	—	.5	—
4-33	07-01-96	42	LAC/LAC	272	8.5	24.0	—	—	.4	—
4-34	07-01-96	42	LAC/LAC	404	8.2	25.0	—	—	.2	—

recovery study at Lancaster, Antelope Valley, California, March 1995 through January 1998—Continued

Hardness, total (mg/L as CaCO_3)	Calcium, dissolved (mg/L)	Magnesium, dissolved (mg/L)	Sodium, dissolved (mg/L)	Potassium, dissolved (mg/L)	Alkalinity, total (mg/L as CaCO_3)	Sulfate, dissolved (mg/L)	Chloride, dissolved (mg/L)	Fluoride, dissolved (mg/L)	Dissolved, solids (mg/L)	Methylene blue active substance (mg/L)	Nitrate (mg/L as NO_3)
Cycle 1 recovery—Continued											
—	—	—	—	—	—	—	14	—	210	—	—
—	—	—	—	—	—	—	7.2	—	192	—	—
—	—	—	—	—	—	—	25	—	256	—	—
—	—	—	—	—	—	—	42	—	314	—	—
—	—	—	—	—	—	—	23	—	238	—	—
—	—	—	—	—	—	—	12	—	212	—	—
—	—	—	—	—	—	—	7.2	—	202	—	—
—	—	—	—	—	—	—	22	—	254	—	—
—	—	—	—	—	—	—	41	—	324	—	—
—	—	—	—	—	—	—	21	—	242	—	—
—	—	—	—	—	—	—	13	—	214	—	—
—	—	—	—	—	—	—	7.2	—	196	—	—
—	—	—	—	—	—	—	22	—	262	—	—
—	—	—	—	—	—	—	41	—	310	—	—
—	—	—	—	—	—	—	24	—	218	—	—
—	—	—	—	—	—	—	11	—	192	—	—
—	—	—	—	—	—	—	7.2	—	174	—	—
—	—	—	—	—	—	—	23	—	240	—	—
—	—	—	—	—	—	—	42	—	296	—	—
—	—	—	—	—	—	—	22	—	214	—	—
—	—	—	—	—	—	—	11	—	190	—	—
—	—	—	—	—	—	—	11	—	—	—	—
—	—	—	—	—	—	—	6.6	—	176	—	—
—	—	—	—	—	—	—	23	—	238	—	—
—	—	—	—	—	—	—	23	—	—	—	—
—	—	—	—	—	—	—	39	—	294	—	—
—	—	—	—	—	—	—	22	—	216	—	—
—	—	—	—	—	—	—	11	—	194	—	—
—	—	—	—	—	—	—	7.2	—	172	—	—
—	—	—	—	—	—	—	24	—	236	—	—
—	—	—	—	—	—	—	42	—	298	—	—
—	—	—	—	—	—	—	22	—	222	—	—
—	—	—	—	—	—	—	12	—	198	—	—
—	—	—	—	—	—	—	6.7	—	178	—	—
—	—	—	—	—	—	—	24	—	246	—	—
—	—	—	—	—	—	—	45	—	314	—	—
—	—	—	—	—	—	—	22	—	222	—	—
—	—	—	—	—	—	—	11	—	190	—	—
—	—	—	—	—	—	—	6.2	—	182	—	—
—	—	—	—	—	—	—	22	—	244	—	—
—	—	—	—	—	—	—	40	—	292	—	—
—	—	—	—	—	—	—	22	—	240	—	—
—	—	—	—	—	—	—	10	—	216	—	—
—	—	—	—	—	—	—	6.7	—	206	—	—
—	—	—	—	—	—	—	22	—	264	—	—

Table 9. Physical properties and major-ion concentrations in water samples collected during cycles 1 and 2 of the injection, storage, and

Sample collection site (local well name)	Sampling date	Day of cycle phase	Collected by/ analyzed by	Specific conductance ($\mu\text{S}/\text{cm}$)	pH (standard units)	Temper- ature, water ($^{\circ}\text{C}$)	Apparent color, unfiltered (units)	Odor threshold at 60°C (TON)	Turbidity (NTU)	Dissolved oxygen (mg/L)
Cycle 1 recovery—Continued										
4-42	07-01-96	42	LAC/LAC	514	8.6	24.0	—	—	3.7	—
4-13	07-02-96	43	LAC/LAC	350	8.5	26.0	—	—	.3	—
4-32	07-02-96	43	LAC/LAC	317	8.3	25.0	—	—	.3	—
4-33	07-02-96	43	LAC/LAC	273	8.5	25.0	—	—	.4	—
4-34	07-02-96	43	LAC/LAC	404	8.2	25.0	—	—	.3	—
4-42	07-02-96	43	LAC/LAC	482	8.7	29.0	—	—	.2	—
4-13	07-03-96	44	LAC/LAC	313	8.5	26.0	—	—	.2	—
4-32	07-03-96	44	LAC/LAC	282	8.3	25.0	—	—	.2	—
4-32	07-03-96	44	AVEK/AVEK	310 (L)	8.1 (L)	—	—	—	—	—
4-33	07-03-96	44	LAC/LAC	244	8.1	25.0	—	—	.2	—
4-34	07-03-96	44	LAC/LAC	364	8.2	25.0	—	—	.3	—
4-34	07-03-96	44	AVEK/AVEK	400 (L)	8.1 (L)	—	—	—	—	—
4-42	07-03-96	44	LAC/LAC	440	8.6	29.0	—	—	.3	—
4-13	07-04-96	45	LAC/LAC	346	8.5	25.5	—	—	.3	—
4-32	07-04-96	45	LAC/LAC	315	8.3	24.5	—	—	.3	—
4-33	07-04-96	45	LAC/LAC	273	8.5	24.5	—	—	.2	—
4-34	07-04-96	45	LAC/LAC	403	8.2	24.5	—	—	.3	—
4-42	07-04-96	45	LAC/LAC	507	8.6	27.0	—	—	.4	—
4-13	07-05-96	46	LAC/LAC	348	8.5	25.5	—	—	.2	—
4-32	07-05-96	46	LAC/LAC	315	8.3	24.5	—	—	.3	—
4-33	07-05-96	46	LAC/LAC	271	8.5	24.0	—	—	.3	—
4-34	07-05-96	46	LAC/LAC	404	8.3	24.5	—	—	.3	—
4-42	07-05-96	46	LAC/LAC	478	8.7	27.0	—	—	.3	—
4-13	07-06-96	47	LAC/LAC	344	8.5	24.5	—	—	.3	—
4-32	07-06-96	47	LAC/LAC	313	8.3	24.0	—	—	.3	—
4-33	07-06-96	47	LAC/LAC	269	8.5	23.0	—	—	.2	—
4-34	07-06-96	47	LAC/LAC	398	8.2	23.0	—	—	.3	—
4-42	07-06-96	47	LAC/LAC	475	8.6	25.5	—	—	.2	—
4-13	07-07-96	48	LAC/LAC	347	8.6	26.5	—	—	.2	—
4-32	07-07-96	48	LAC/LAC	317	8.3	24.5	—	—	.3	—
4-33	07-07-96	48	LAC/LAC	272	8.6	24.5	—	—	.3	—
4-34	07-07-96	48	LAC/LAC	405	8.3	25.0	—	—	.3	—
4-42	07-07-96	48	LAC/LAC	480	8.7	27.0	—	—	.3	—
4-32	07-11-96	52	AVEK/AVEK	305 (L)	8.2 (L)	—	—	—	—	—
4-34	07-11-96	52	AVEK/AVEK	395 (L)	8.1 (L)	—	—	—	—	—
4-13	07-12-96	53	LAC/LAC	342	8.6	26.0	—	—	.2	—
4-32	07-12-96	53	LAC/LAC	311	8.4	25.0	—	—	.3	—
4-33	07-12-96	53	LAC/LAC	271	8.6	24.5	—	—	.3	—
4-34	07-12-96	53	LAC/LAC	401	8.4	25.0	—	—	.3	—
4-42	07-12-96	53	LAC/LAC	495	8.7	27.0	—	—	.3	—
4-32	07-18-96	59	AVEK/AVEK	300 (L)	8.2 (L)	—	—	—	—	—
4-34	07-18-96	59	AVEK/AVEK	400 (L)	8.1 (L)	—	—	—	—	—
4-13	07-19-96	60	LAC/LAC	345	8.5	25.5	—	—	.2	—
4-32	07-19-96	60	LAC/LAC	311	8.4	24.5	—	—	.2	—
4-33	07-19-96	60	LAC/LAC	269	8.5	23.5	—	—	.2	—

recovery study at Lancaster, Antelope Valley, California, March 1995 through January 1998—Continued

Hardness, total (mg/L as CaCO_3)	Calcium, dissolved (mg/L)	Magnesium, dissolved (mg/L)	Sodium, dissolved (mg/L)	Potassium, dissolved (mg/L)	Alkalinity, total (mg/L as CaCO_3)	Sulfate, dissolved (mg/L)	Chloride, dissolved (mg/L)	Fluoride, dissolved (mg/L)	Dissolved, solids (mg/L)	Methylene blue active substance (mg/L)	Nitrate (mg/L as NO_3)
Cycle 1 recovery—Continued											
—	—	—	—	—	—	—	47	—	330	—	—
—	—	—	—	—	—	—	23	—	240	—	—
—	—	—	—	—	—	—	11	—	222	—	—
—	—	—	—	—	—	—	6.2	—	188	—	—
—	—	—	—	—	—	—	23	—	262	—	—
—	—	—	—	—	—	—	40	—	316	—	—
—	—	—	—	—	—	—	23	—	214	—	—
—	—	—	—	—	—	—	11	—	192	—	—
—	—	—	—	—	—	—	11	—	—	—	—
—	—	—	—	—	—	—	6.2	—	174	—	—
—	—	—	—	—	—	—	22	—	238	—	—
—	—	—	—	—	—	—	23	—	—	—	—
—	—	—	—	—	—	—	30	—	286	—	—
—	—	—	—	—	—	—	23	—	216	—	—
—	—	—	—	—	—	—	11	—	188	—	—
—	—	—	—	—	—	—	7.2	—	166	—	—
—	—	—	—	—	—	—	23	—	236	—	—
—	—	—	—	—	—	—	46	—	308	—	—
—	—	—	—	—	—	—	23	—	208	—	—
—	—	—	—	—	—	—	9.8	—	188	—	—
—	—	—	—	—	—	—	6.2	—	168	—	—
—	—	—	—	—	—	—	23	—	248	—	—
—	—	—	—	—	—	—	41	—	300	—	—
—	—	—	—	—	—	—	22	—	216	—	—
—	—	—	—	—	—	—	12	—	198	—	—
—	—	—	—	—	—	—	6.2	—	170	—	—
—	—	—	—	—	—	—	23	—	242	—	—
—	—	—	—	—	—	—	42	—	284	—	—
—	—	—	—	—	—	—	23	—	212	—	—
—	—	—	—	—	—	—	9.8	—	190	—	—
—	—	—	—	—	—	—	6.7	—	170	—	—
—	—	—	—	—	—	—	22	—	234	—	—
—	—	—	—	—	—	—	41	—	294	—	—
—	—	—	—	—	—	—	10	—	—	—	—
—	—	—	—	—	—	—	23	—	—	—	—
—	—	—	—	—	—	—	21	—	210	—	—
—	—	—	—	—	—	—	9.0	—	188	—	—
—	—	—	—	—	—	—	6.1	—	168	—	—
—	—	—	—	—	—	—	21	—	234	—	—
—	—	—	—	—	—	—	42	—	310	—	—
—	—	—	—	—	—	—	10	—	—	—	—
—	—	—	—	—	—	—	23	—	—	—	—
—	—	—	—	—	—	—	21	—	206	—	—
—	—	—	—	—	—	—	8.7	—	188	—	—
—	—	—	—	—	—	—	5.9	—	166	—	—

Table 9. Physical properties and major-ion concentrations in water samples collected during cycles 1 and 2 of the injection, storage, and

Sample collection site (local well name)	Sampling date	Day of cycle phase	Collected by/ analyzed by	Specific conductance ($\mu\text{S}/\text{cm}$)	pH (standard units)	Temperature, water (°C)	Apparent color, unfiltered (units)	Odor threshold at 60°C (TON)	Turbidity (NTU)	Dissolved oxygen (mg/L)
Cycle 1 recovery—Continued										
4-34	07-19-96	60	LAC/LAC	402	8.3	24.5	—	—	0.4	—
4-42	07-19-96	60	LAC/LAC	470	8.7	26.5	—	—	.2	—
4-13	07-25-96	66	LAC/LAC	347	8.6	26.5	—	—	.3	—
4-32	07-25-96	66	LAC/LAC	324	8.4	25.5	—	—	.3	—
4-33	07-25-96	66	LAC/LAC	274	8.6	24.5	—	—	.2	—
4-42	07-25-96	66	LAC/LAC	474	8.7	27.5	—	—	.4	—
4-5	07-26-96	67	LAC/LAC	241 (L)	7.8 (L)	—	—	—	—	—
4-9	07-26-96	67	LAC/LAC	290 (L)	8.5 (L)	—	—	—	—	—
4-12	07-26-96	67	LAC/LAC	299 (L)	8.0 (L)	—	—	—	—	—
4-17	07-26-96	67	LAC/LAC	450 (L)	8.4 (L)	—	—	—	—	—
4-25	07-26-96	67	LAC/LAC	255 (L)	7.8 (L)	—	—	—	—	—
4-26	07-26-96	67	LAC/LAC	279 (L)	8.4 (L)	—	—	—	—	—
4-37	07-26-96	67	LAC/LAC	280 (L)	7.9 (L)	—	—	—	—	—
4-38	07-26-96	67	LAC/LAC	256 (L)	7.9 (L)	—	—	—	—	—
4-13	08-01-96	73	LAC/LAC	301	8.6	27.0	—	—	.2	—
4-32	08-01-96	73	LAC/LAC	293	8.4	26.0	—	—	.4	—
4-33	08-01-96	73	LAC/LAC	237	8.6	25.0	—	—	.3	—
4-42	08-01-96	73	LAC/LAC	411	8.7	27.0	—	—	.4	—
4-13	08-08-96	80	LAC/LAC	335	8.6	26.0	—	—	.3	—
4-32	08-08-96	80	LAC/LAC	346	8.4	25.0	—	—	.4	—
4-33	08-08-96	80	LAC/LAC	272	8.6	24.0	—	—	.3	—
4-42	08-08-96	80	LAC/LAC	466	8.7	27.0	—	—	.8	—
4-13	08-15-96	87	LAC/LAC	332	8.6	25.0	—	—	.2	—
4-32	08-15-96	87	LAC/LAC	347	8.3	23.5	—	—	.2	—
4-42	08-15-96	87	LAC/LAC	445	8.7	26.0	—	—	.4	—
4-13	08-22-96	94	LAC/LAC	336	8.4	24.5	—	—	.2	—
4-32	08-22-96	94	LAC/LAC	351	8.3	23.5	—	—	.2	—
4-42	08-22-96	94	LAC/LAC	451	8.5	25.5	—	—	.4	—
Cycle 2 pre-injection										
5K8-PZ1	10-31-96	11	USGS/LAC	614	8.2	24.0	0	0	0.1 (L)	0.8
5K8-PZ2	10-31-96	11	USGS/LAC	862	8.6	23.0	5	0	3.5 (L)	.5
5K8-PZ3	10-31-96	11	USGS/LAC	883	7.7	24.0	0	0	.1 (L)	1.2
5K8-PZ4	10-31-96	11	USGS/LAC	321	7.9	22.0	5	0	3.1 (L)	9.0
4-5	10-31-96	11	LAC/LAC	248 (L)	8.0 (L)	—	0	0	.1 (L)	—
4-9	10-31-96	11	LAC/LAC	294 (L)	8.4 (L)	—	0	0	.1 (L)	—
4-25	10-31-96	11	LAC/LAC	243 (L)	7.8 (L)	—	0	0	.8 (L)	—
4-26	10-31-96	11	LAC/LAC	285 (L)	8.4 (L)	—	0	0	.1 (L)	—
4-29	10-31-96	11	LAC/LAC	384 (L)	7.8 (L)	—	5	0	1.0 (L)	—
4-37	10-31-96	11	LAC/LAC	320 (L)	7.9 (L)	—	0	0	.1 (L)	—
4-38	10-31-96	11	LAC/LAC	253 (L)	8.1 (L)	—	0	0	.1 (L)	—
4-44	10-31-96	11	LAC/LAC	922 (L)	7.8 (L)	—	0	0	.2 (L)	—
4-12	11-01-96	12	LAC/LAC	295 (L)	8.1 (L)	—	0	0	.1 (L)	—
4-13	11-01-96	12	LAC/LAC	347 (L)	8.1 (L)	—	0	0	.6 (L)	—
4-17	11-01-96	12	LAC/LAC	496 (L)	8.2 (L)	—	0	0	.2 (L)	—

recovery study at Lancaster, Antelope Valley, California, March 1995 through January 1998—Continued

Hardness, total (mg/L as CaCO_3)	Calcium, dissolved (mg/L)	Magnesium, dissolved (mg/L)	Sodium, dissolved (mg/L)	Potassium, dissolved (mg/L)	Alkalinity, total (mg/L as CaCO_3)	Sulfate, dissolved (mg/L)	Chloride, dissolved (mg/L)	Fluoride, dissolved (mg/L)	Dissolved, solids (mg/L)	Methylene blue active substance (mg/L)	Nitrate (mg/L as NO_3)
Cycle 1 recovery—Continued											
—	—	—	—	—	—	—	21	—	240	—	—
—	—	—	—	—	—	—	36	—	288	—	—
—	—	—	—	—	—	—	22	—	208	—	—
—	—	—	—	—	—	—	11	—	198	—	—
—	—	—	—	—	—	—	6.1	—	176	—	—
—	—	—	—	—	—	—	40	—	286	—	—
58	18	3.4	29	1	98 (L)	16	5.0	0.2	148	< 0.05	2.1
12	4.2	.3	62	.6	118 (L)	19	5.8	.7	182	< .05	2.3
28	9.6	1.0	59	.9	134 (L)	17	3.6	.7	184	< .05	2.3
18	6.4	.6	93	1	136 (L)	34	33	1.1	270	< .05	3.1
48	14	2.9	38	1	108 (L)	16	3.6	.3	156	< .05	2.8
22	7.2	.9	56	.6	119 (L)	18	4.5	.6	168	< .05	2.3
46	16	1.5	42	1	123 (L)	19	7.9	.5	185	< .05	1.3
47	14	2.6	39	1	112 (L)	17	3.8	.3	162	< .05	2.3
—	—	—	—	—	—	—	22	—	220	—	—
—	—	—	—	—	—	—	13	—	226	—	—
—	—	—	—	—	—	—	6.1	—	176	—	—
—	—	—	—	—	—	—	38	—	288	—	—
—	—	—	—	—	—	—	20	—	210	—	—
—	—	—	—	—	—	—	15	—	212	—	—
—	—	—	—	—	—	—	5.9	—	170	—	—
—	—	—	—	—	—	—	41	—	278	—	—
—	—	—	—	—	—	—	19	—	200	—	—
—	—	—	—	—	—	—	15	—	214	—	—
—	—	—	—	—	—	—	37	—	266	—	—
—	—	—	—	—	—	—	19	—	206	—	—
—	—	—	—	—	—	—	14	—	220	—	—
—	—	—	—	—	—	—	35	—	270	—	—
Cycle 2 pre-injection											
58	20	1.9	100	2	115	95	66	0.5	376	< 0.05	2.5
18	4.0	1.9	170	.9	120	160	86	.4	530	< .05	2.7
210	71	8.3	95	3	106	170	100	.3	576	< .05	3.4
66	20	3.9	34	2	100	24	18	.2	194	< .05	1.4
46	14	2.7	38	1	102 (L)	13	4.5	.3	138	< .05	.99
12	4.0	.5	58	.7	118 (L)	16	6.3	.7	172	< .05	.95
50	17	1.9	34	1	107 (L)	11	2.6	.3	140	< .05	1.0
20	6.4	1.0	54	.8	118 (L)	14	5.3	.7	168	< .05	1.0
38	12	1.9	68	1	123 (L)	37	18	.6	226	< .05	1.0
56	18	3.0	46	1	109 (L)	23	16	.4	180	< .05	2.2
44	16	1.0	40	1	112 (L)	12	2.9	.4	142	< .05	1.0
220	84	1.9	82	5	107 (L)	190	97	.3	588	< .05	3.5
28	9.2	1.2	52	.9	132 (L)	12	2.9	.8	190	< .05	.88
30	10	1.0	56	1	101 (L)	27	25	.5	214	< .05	1.1
34	12	1.0	87	2	116 (L)	41	55	.7	304	< .05	2.1

Table 9. Physical properties and major-ion concentrations in water samples collected during cycles 1 and 2 of the injection, storage, and

Sample collection site (local well name)	Sampling date	Day of cycle phase	Collected by/ analyzed by	Specific conductance ($\mu\text{S}/\text{cm}$)	pH (standard units)	Tempera-ture, water ($^{\circ}\text{C}$)	Apparent color, unfiltered (units)	Odor threshold at 60°C (TON)	Turbidity (NTU)	Dissolved oxygen (mg/L)
Cycle 2 pre-injection—Continued										
4-30	11-01-96	12	LAC/LAC	462 (L)	7.9 (L)	—	0	0	0.1 (L)	—
4-32	11-01-96	12	LAC/LAC	338 (L)	8.1 (L)	—	0	0	2.2 (L)	—
4-32	11-01-96	12	AVEK/AVEK	330 (L)	8.6 (L)	—	—	—	—	—
4-33	11-01-96	12	LAC/LAC	249 (L)	8.0 (L)	—	0	0	.2 (L)	—
4-34	11-01-96	12	LAC/LAC	405 (L)	8.1 (L)	—	0	0	1.0 (L)	—
4-34	11-01-96	12	AVEK/AVEK	400 (L)	7.9 (L)	—	—	—	—	—
4-42	11-01-96	12	LAC/LAC	566 (L)	8.4 (L)	—	0	0	1.6 (L)	—
4-43	11-01-96	12	LAC/LAC	1,120 (L)	7.7 (L)	—	0	0	.2 (L)	—
DK8-PZ1	11-07-96	18	USGS/LAC	680	8.7	24.5	< 5	0	.4 (L)	—
Cycle 2 injection										
4-32(AVEK)	11-12-96	1	LAC/LAC	295	7.0	19.0	< 5	0	0.3	—
4-34(AVEK)	11-12-96	1	LAC/LAC	297 (L)	6.9 (L)	—	< 5	0	.2 (L)	—
4-32(AVEK)	11-12-96	1	AVEK/AVEK	300 (L)	7.1 (L)	—	—	—	—	—
4-32(AVEK)	11-21-96	10	LAC/LAC	295	7.0	11.5	—	—	.1	—
4-34(AVEK)	11-21-96	10	LAC/LAC	296	7.0	11.5	—	—	.1	—
4-32(AVEK)	11-21-96	10	AVEK/AVEK	300 (L)	7.0 (L)	—	—	—	—	—
4-32(AVEK)	11-27-96	16	LAC/LAC	306	7.1	12.0	—	—	.1	—
4-34(AVEK)	11-27-96	16	LAC/LAC	307	7.1	12.0	—	—	.1	—
4-32(AVEK)	11-27-96	16	AVEK/AVEK	310 (L)	7.1 (L)	—	—	—	—	—
4-32(AVEK)	12-05-96	24	LAC/LAC	327	7.1	10.0	—	—	.1	—
4-34(AVEK)	12-05-96	24	LAC/LAC	328	7.1	10.0	—	—	.1	—
4-32(AVEK)	12-05-96	24	AVEK/AVEK	340 (L)	7.0 (L)	—	—	—	—	—
4-32(AVEK)	12-12-96	31	LAC/LAC	337	7.1	10.0	—	—	.1	—
4-34(AVEK)	12-12-96	31	LAC/LAC	337	7.1	10.0	—	—	.1	—
4-32(AVEK)	12-12-96	31	AVEK/AVEK	340 (L)	7.1 (L)	—	—	—	—	—
4-32(AVEK)	12-19-96	38	LAC/LAC	344	7.1	9.0	—	—	.1	—
4-34(AVEK)	12-19-96	38	LAC/LAC	344	7.1	9.0	—	—	.1	—
4-32(AVEK)	12-19-96	38	AVEK/AVEK	340 (L)	7.1 (L)	—	—	—	—	—
4-32(AVEK)	12-26-96	45	LAC/LAC	430	7.0	9.0	—	—	.1	—
4-34(AVEK)	12-26-96	45	LAC/LAC	431	7.1	9.0	—	—	.1	—
4-32(AVEK)	12-26-96	45	AVEK/AVEK	430 (L)	7.0 (L)	—	—	—	—	—
4-32(AVEK)	01-02-97	52	LAC/LAC	493	7.0	10.0	—	—	.1	—
4-34(AVEK)	01-02-97	52	LAC/LAC	495	7.0	10.0	—	—	.1	—
4-32(AVEK)	01-02-97	52	AVEK/AVEK	500 (L)	6.9 (L)	—	—	—	—	—
4-32(AVEK)	01-09-97	59	LAC/LAC	495	7.0	9.0	0	0	.2	—
4-34(AVEK)	01-09-97	59	LAC/LAC	495	7.0	9.0	0	0	.2	—
4-32(AVEK)	01-09-97	59	AVEK/AVEK	510 (L)	7.1 (L)	—	—	—	—	—
4-32(AVEK)	01-16-97	66	LAC/LAC	425	7.0	8.0	—	—	.2	—
4-34(AVEK)	01-16-97	66	LAC/LAC	425	7.0	8.0	—	—	.2	—
4-32(AVEK)	01-16-97	66	AVEK/AVEK	430 (L)	6.9 (L)	—	—	—	—	—
4-32(AVEK)	01-23-97	73	LAC/LAC	418	7.0	8.0	—	—	.2	—
4-34(AVEK)	01-23-97	73	LAC/LAC	418	7.0	8.0	—	—	.2	—
4-32(AVEK)	01-23-97	73	AVEK/AVEK	420 (L)	6.9 (L)	—	—	—	—	—
4-32(AVEK)	01-30-97	80	AVEK/AVEK	360 (L)	6.8 (L)	—	—	—	—	—
4-32(AVEK)	01-31-97	81	LAC/LAC	363	6.9	10.0	—	—	.2	—
4-34(AVEK)	01-31-97	81	LAC/LAC	364	6.9	10.0	—	—	.2	—

recovery study at Lancaster, Antelope Valley, California, March 1995 through January 1998—Continued

Hardness, total (mg/L as CaCO_3)	Calcium, dissolved (mg/L)	Magnesium, dissolved (mg/L)	Sodium, dissolved (mg/L)	Potassium, dissolved (mg/L)	Alkalinity, total (mg/L as CaCO_3)	Sulfate, dissolved (mg/L)	Chloride, dissolved (mg/L)	Fluoride, dissolved (mg/L)	Dissolved, solids (mg/L)	Methylene blue active substance (mg/L)	Nitrate (mg/L as NO_3)
Cycle 2 pre-injection—Continued											
82	26	3.9	59	2	131 (L)	52	28	.4	270	< 0.05	1.3
46	12	3.6	50	1	109 (L)	24	19	.4	204	< .05	2.5
—	—	—	—	—	—	—	—	—	—	—	—
51	17	1.9	34	1	93 (L)	15	6.8	.2	160	< .05	1.3
22	8.0	.5	73	1	134 (L)	34	21	.3	248	< .05	1.4
—	—	—	—	—	—	—	—	—	—	—	—
30	8.0	2.4	100	2	125 (L)	56	64	.9	340	< .05	2.2
220	83	3.4	140	4	96 (L)	210	160	.3	660	< .05	3.4
50	15	2.9	130	2	69	55	140	.4	402	< .05	1.4
Cycle 2 injection											
80	15	10	20	2	48 (L)	37	32	< 0.1	174	< 0.05	0.67
80	16	9.7	21	2	50 (L)	37	32	< .1	174	< .05	.68
—	—	—	—	—	—	—	29	—	—	—	—
—	—	—	—	—	—	36	31	—	172	—	.63
—	—	—	—	—	—	18	11	—	176	—	4.2
—	—	—	—	—	—	—	29	—	—	—	—
—	—	—	—	—	—	37	37	—	218	—	.60
—	—	—	—	—	—	37	37	—	220	—	.63
—	—	—	—	—	—	—	34	—	—	—	—
—	—	—	—	—	—	38	42	—	242	—	.77
—	—	—	—	—	—	38	42	—	242	—	.76
—	—	—	—	—	—	39	44	—	220	—	.81
—	—	—	—	—	—	39	44	—	222	—	.84
—	—	—	—	—	—	40	—	—	—	—	—
—	—	—	—	—	—	42	49	—	218	—	.60
—	—	—	—	—	—	42	49	—	216	—	.51
—	—	—	—	—	—	—	47	—	—	—	—
—	—	—	—	—	—	49	76	—	284	—	2.9
—	—	—	—	—	—	49	76	—	288	—	2.9
—	—	—	—	—	—	—	67	—	—	—	—
—	—	—	—	—	—	62	89	—	322	—	3.2
—	—	—	—	—	—	62	89	—	326	—	3.3
102	20	13	61	4	49 (L)	59	94	< .1	326	< .05	3.4
101	20	13	60	4	51 (L)	57	94	< .1	328	< .05	3.3
—	—	—	—	—	—	—	80	—	—	—	—
—	—	—	—	—	—	49	74	—	270	—	2.8
—	—	—	—	—	—	49	74	—	270	—	2.7
—	—	—	—	—	—	—	67	—	—	—	—
—	—	—	—	—	—	47	73	—	264	—	2.8
—	—	—	—	—	—	47	73	—	268	—	2.8
—	—	—	—	—	—	—	65	—	—	—	—
—	—	—	—	—	—	—	53	—	—	—	—
—	—	—	—	—	—	42	56	—	232	—	3.1
—	—	—	—	—	—	42	56	—	234	—	3.1

Table 9. Physical properties and major-ion concentrations in water samples collected during cycles 1 and 2 of the injection, storage, and

Sample collection site (local well name)	Sampling date	Day of cycle phase	Collected by/ analyzed by	Specific conductance ($\mu\text{S}/\text{cm}$)	pH (standard units)	Tempera-ture, water ($^{\circ}\text{C}$)	Apparent color, unfiltered (units)	Odor threshold at 60°C (TON)	Turbidity (NTU)	Dissolved oxygen (mg/L)
Cycle 2 injection—Continued										
4-5	02-05-97	86	LAC/LAC	248 (L)	7.9 (L)	—	0	0	0.1 (L)	—
4-9	02-05-97	86	LAC/LAC	311 (L)	8.0 (L)	—	0	0	.2 (L)	—
4-12	02-05-97	86	LAC/LAC	298 (L)	8.0 (L)	—	0	0	.1 (L)	—
4-13	02-05-97	86	LAC/LAC	580 (L)	8.3 (L)	—	0	0	.3 (L)	—
4-17	02-05-97	86	LAC/LAC	510 (L)	8.0 (L)	—	5	0	.6 (L)	—
4-25	02-05-97	86	LAC/LAC	253 (L)	7.9 (L)	—	0	0	.1 (L)	—
4-26	02-05-97	86	LAC/LAC	304 (L)	8.2 (L)	—	0	0	.1 (L)	—
4-29	02-05-97	86	LAC/LAC	406 (L)	7.7 (L)	—	0	0	.6 (L)	—
4-30	02-05-97	86	LAC/LAC	474 (L)	8.0 (L)	—	0	0	.2 (L)	—
4-33	02-05-97	86	LAC/LAC	354 (L)	7.9 (L)	—	0	0	.3 (L)	—
4-37	02-05-97	86	LAC/LAC	214 (L)	8.2 (L)	—	0	0	.1 (L)	—
4-38	02-05-97	86	LAC/LAC	258 (L)	8.2 (L)	—	0	0	<.1 (L)	—
4-42	02-05-97	86	LAC/LAC	637 (L)	8.4 (L)	—	0	0	.1 (L)	—
4-43	02-05-97	86	LAC/LAC	1,040(L)	7.9 (L)	—	0	0	.1 (L)	—
4-44	02-06-97	87	LAC/LAC	930 (L)	7.8 (L)	—	0	0	.2 (L)	—
4-32(AVEK)	02-06-97	87	LAC/LAC	376	6.9	10.0	—	—	.2	—
4-34(AVEK)	02-06-97	87	LAC/LAC	376	6.9	10.0	—	—	.2	—
4-32(AVEK)	02-06-97	87	AVEK/AVEK	380 (L)	6.9 (L)	—	—	—	—	—
4-32(AVEK)	02-13-97	94	LAC/LAC	412	6.8	10.0	0	0	.1	—
4-34(AVEK)	02-13-97	94	LAC/LAC	412 (L)	7.1 (L)	—	0	0	.2 (L)	—
4-32(AVEK)	02-13-97	94	AVEK/AVEK	400 (L)	7.0 (L)	—	—	—	—	—
4-32(AVEK)	02-20-97	101	LAC/LAC	408	6.9	10.0	—	—	.1	—
4-34(AVEK)	02-20-97	101	LAC/LAC	408	6.9	10.0	—	—	.1	—
4-32(AVEK)	02-20-97	101	AVEK/AVEK	430 (L)	7.1 (L)	—	—	—	—	—
4-32(AVEK)	02-27-97	108	LAC/LAC	427	6.9	10.0	—	—	.2	—
4-34(AVEK)	02-27-97	108	LAC/LAC	426	6.9	10.0	—	—	.1	—
4-32(AVEK)	02-27-97	108	AVEK/AVEK	430 (L)	7.0 (L)	—	—	—	—	—
4-32(AVEK)	03-06-97	115	LAC/LAC	146	6.8	9.5	—	—	.1	—
4-34(AVEK)	03-06-97	115	LAC/LAC	146	6.8	9.5	—	—	.1	—
4-32(AVEK)	03-06-97	115	AVEK/AVEK	150 (L)	6.6 (L)	—	—	—	—	—
4-32(AVEK)	03-13-97	122	LAC/LAC	140	6.8	12.0	—	—	.2	—
4-32(AVEK)	03-13-97	122	AVEK/AVEK	140 (L)	6.7 (L)	—	—	—	—	—
4-32(AVEK)	03-20-97	129	LAC/LAC	295	6.8	15.0	—	—	.1	—
4-34(AVEK)	03-20-97	129	LAC/LAC	295	6.8	15.0	—	—	.1	—
4-32(AVEK)	03-20-97	129	AVEK/AVEK	300 (L)	6.5 (L)	—	—	—	—	—
4-32(AVEK)	03-27-97	136	LAC/LAC	274	6.7	16.0	—	—	.1	—
4-34(AVEK)	03-27-97	136	LAC/LAC	274	6.7	16.0	—	—	.1	—
4-32(AVEK)	03-27-97	136	AVEK/AVEK	280 (L)	6.7 (L)	—	—	—	—	—
4-32(AVEK)	04-03-97	143	LAC/LAC	376	6.8	15.0	—	—	.1	—
4-34(AVEK)	04-03-97	143	LAC/LAC	376	6.8	15.0	—	—	.1	—
4-32(AVEK)	04-03-97	143	AVEK/AVEK	380 (L)	6.8 (L)	—	—	—	—	—
4-32(AVEK)	04-10-97	150	LAC/LAC	434	6.9	15.0	—	—	.1	—
4-32(AVEK)	04-10-97	150	AVEK/AVEK	440 (L)	6.8 (L)	—	—	—	—	—
4-32(AVEK)	04-17-97	157	LAC/LAC	433	6.9	17.0	—	—	.1	—
4-34(AVEK)	04-17-97	157	LAC/LAC	432	6.9	17.0	—	—	.1	—
4-32(AVEK)	04-17-97	157	AVEK/AVEK	430 (L)	6.9 (L)	—	—	—	—	—

recovery study at Lancaster, Antelope Valley, California, March 1995 through January 1998—Continued

Hardness, total (mg/L as CaCO_3)	Calcium, dissolved (mg/L)	Magnesium, dissolved (mg/L)	Sodium, dissolved (mg/L)	Potassium, dissolved (mg/L)	Alkalinity, total (mg/L as CaCO_3)	Sulfate, dissolved (mg/L)	Chloride, dissolved (mg/L)	Fluoride, dissolved (mg/L)	Dissolved, solids (mg/L)	Methylene blue active substance (mg/L)	Nitrate (mg/L as NO_3)
Cycle 2 injection—Continued											
51	16	2.9	29	0.9	96 (L)	12	3.8	0.2	170	< 0.05	< 0.03
18	4.8	1.5	46	.6	108 (L)	18	11	.5	212	< .05	< .03
29	8.0	2.1	45	.9	123 (L)	12	2.6	.7	208	< .05	< .03
30	10	1.0	92	2	107 (L)	59	74	.5	346	< .05	< .03
32	12	.5	76	2	108 (L)	45	57	.6	328	< .05	2.1
49	14	3.6	33	1	108 (L)	11	2.5	.3	172	< .05	< .03
27	9.3	.9	47	.7	117 (L)	16	8.1	.5	203	< .05	< .03
40	12	2.4	53	1	120 (L)	39	20	.6	264	< .05	1.1
84	29	2.9	56	2	128 (L)	54	28	.3	296	< .05	< .03
79	26	3.6	36	1	96 (L)	28	26	.2	232	< .05	< .03
50	16	2.4	42	1	115 (L)	19	10	.4	214	< .05	< .03
56	17	3.4	30	1	107 (L)	13	3.2	.2	176	< .05	< .03
26	8.0	1.5	110	2	128 (L)	66	74	.9	400	< .05	< .03
240	91	2.4	95	4	94 (L)	180	140	.2	672	< .05	3.3
230	86	3.9	84	4	100 (L)	180	97	.3	612	< .05	3.7
—	—	—	—	—	—	46	61	—	240	—	3.0
—	—	—	—	—	—	47	62	—	242	—	3.0
—	—	—	—	—	—	—	55	—	—	—	—
80	17	9.2	40	4	35 (L)	47	69	< .1	266	—	2.3
82	17	9.7	36	4	32 (L)	47	70	< .1	268	—	2.3
—	—	—	—	—	—	—	63	—	—	—	—
—	—	—	—	—	—	55	74	—	246	—	.09
—	—	—	—	—	—	55	74	—	248	—	.08
—	—	—	—	—	—	—	67	—	—	—	—
—	—	—	—	—	—	55	65	—	262	—	< .03
—	—	—	—	—	—	55	62	—	258	—	< .03
—	—	—	—	—	—	—	67	—	—	—	—
—	—	—	—	—	—	27	6.7	—	98	—	.27
—	—	—	—	—	—	27	6.6	—	96	—	.25
—	—	—	—	—	—	—	7.8	—	—	—	—
—	—	—	—	—	—	26	4.7	—	94	—	< .03
—	—	—	—	—	—	—	5.6	—	—	—	—
—	—	—	—	—	—	54	37	—	184	—	1.7
—	—	—	—	—	—	53	36	—	186	—	1.8
—	—	—	—	—	—	—	34	—	—	—	—
—	—	—	—	—	—	50	30	—	168	—	1.8
—	—	—	—	—	—	50	31	—	166	—	1.8
—	—	—	—	—	—	—	30	—	—	—	—
—	—	—	—	—	—	74	49	—	236	—	3.1
—	—	—	—	—	—	74	49	—	232	—	3.0
—	—	—	—	—	—	—	43	—	—	—	—
—	—	—	—	—	—	77	58	—	262	—	3.7
—	—	—	—	—	—	—	52	—	—	—	—
—	—	—	—	—	—	74	57	—	260	—	3.7
—	—	—	—	—	—	74	57	—	260	—	3.7
—	—	—	—	—	—	—	52	—	—	—	—

Table 9. Physical properties and major-ion concentrations in water samples collected during cycles 1 and 2 of the injection, storage, and

Sample collection site (local well name)	Sampling date	Day of cycle phase	Collected by/ analyzed by	Specific conductance ($\mu\text{S}/\text{cm}$)	pH (standard units)	Temper- ature, water ($^{\circ}\text{C}$)	Apparent color, unfiltered (units)	Odor threshold at 60°C (TON)	Turbidity (NTU)	Dissolved oxygen (mg/L)
Cycle 2 storage										
5K8-PZ1	05-06-97	20	USGS/LAC	530	8.5	23.5	0	0	0.1 (L)	—
5K8-PZ2	05-06-97	20	USGS/LAC	834	8.5	26.5	0	0	.2 (L)	—
5K8-PZ3	05-06-97	20	USGS/LAC	906	7.7	27.0	0	0	.1 (L)	—
5K8-PZ4	05-06-97	20	USGS/LAC	369	7.9	23.0	0	0	1.6 (L)	—
4-5	05-06-97	20	LAC/LAC	248 (L)	8.0 (L)	—	0	0	<.1 (L)	—
4-9	05-06-97	20	LAC/LAC	320 (L)	8.4 (L)	—	0	0	.1 (L)	—
4-12	05-06-97	20	LAC/LAC	294 (L)	8.0 (L)	—	0	0	<.1 (L)	—
4-25	05-06-97	20	LAC/LAC	248 (L)	7.9 (L)	—	0	0	<.1 (L)	—
4-26	05-06-97	20	LAC/LAC	311 (L)	8.3 (L)	—	0	0	.1 (L)	—
4-37	05-06-97	20	LAC/LAC	321 (L)	8.0 (L)	—	0	0	<.1 (L)	—
4-38	05-06-97	20	LAC/LAC	256 (L)	7.9 (L)	—	0	0	<.1 (L)	—
4-29	05-07-97	21	LAC/LAC	377 (L)	7.8 (L)	—	0	0	.5 (L)	—
4-30	05-07-97	21	LAC/LAC	435 (L)	8.0 (L)	—	0	0	.1 (L)	—
4-34	05-07-97	21	LAC/LAC	422 (L)	7.0 (L)	—	5	0	12 (L)	—
4-43	05-07-97	21	LAC/LAC	1,010 (L)	7.9 (L)	—	0	0	.1 (L)	—
DK8-PZ1	05-08-97	22	USGS/LAC	719	8.3	26.0	0	0	.1 (L)	—
4-17	05-08-97	22	LAC/LAC	514 (L)	8.3 (L)	—	0	0	.3 (L)	—
4-44	05-08-97	22	LAC/LAC	937 (L)	7.9 (L)	—	0	0	.2 (L)	—
4-13	05-09-97	23	LAC/LAC	605 (L)	8.4 (L)	—	0	0	.2 (L)	—
4-33	05-09-97	23	LAC/LAC	275 (L)	8.0 (L)	—	0	0	.1 (L)	—
4-42	05-09-97	23	LAC/LAC	630 (L)	8.4 (L)	—	0	0	.2 (L)	—
Cycle 2 recovery										
4-13	05-14-97	1	LAC/LAC	595	8.5	27.0	—	—	0.3	—
4-32	05-14-97	1	LAC/LAC	412	7.1	16.0	—	—	1.5	—
4-33	05-14-97	1	LAC/LAC	257	7.9	22.0	—	—	.2	—
4-34	05-14-97	1	LAC/LAC	415	6.9	16.0	—	—	2.2	—
4-42	05-14-97	1	LAC/LAC	622	8.5	29.0	—	—	.1	—
4-13	05-15-97	2	LAC/LAC	513	8.5	26.0	—	—	.2	—
4-32	05-15-97	2	LAC/LAC	424	6.9	16.0	—	—	.3	—
4-33	05-15-97	2	LAC/LAC	307	7.9	22.0	—	—	.2	—
4-34	05-15-97	2	LAC/LAC	430	6.8	16.0	—	—	.4	—
4-42	05-15-97	2	LAC/LAC	611	8.5	29.0	—	—	.1	—
4-13	05-16-97	3	LAC/LAC	485	8.5	26.0	—	—	.2	—
4-32	05-16-97	3	LAC/LAC	422	6.9	16.0	—	—	.2	—
4-32	05-16-97	3	AVEK/AVEK	430 (L)	7.0 (L)	—	—	—	—	—
4-33	05-16-97	3	LAC/LAC	318	7.9	22.0	—	—	.2	—
4-34	05-16-97	3	LAC/LAC	426	6.9	16.0	—	—	.2	—
4-34	05-16-97	3	AVEK/AVEK	400 (L)	7.0 (L)	—	—	—	—	—
4-42	05-16-97	3	LAC/LAC	617	8.6	28.5	—	—	<.1	—
4-13	05-17-97	4	LAC/LAC	460	8.4	25.0	—	—	.1	—
4-32	05-17-97	4	LAC/LAC	420	7.0	15.0	—	—	.2	—
4-33	05-17-97	4	LAC/LAC	329	7.9	22.5	—	—	.2	—

recovery study at Lancaster, Antelope Valley, California, March 1995 through January 1998—Continued

Hardness, total (mg/L as CaCO_3)	Calcium, dissolved (mg/L)	Magnesium, dissolved (mg/L)	Sodium, dissolved (mg/L)	Potassium, dissolved (mg/L)	Alkalinity, total (mg/L as CaCO_3)	Sulfate, dissolved (mg/L)	Chloride, dissolved (mg/L)	Fluoride, dissolved (mg/L)	Dissolved, solids (mg/L)	Methylene blue active substance (mg/L)	Nitrate (mg/L as NO_3)
Cycle 2 storage											
48	12	4.4	91	2	124	64	50	0.6	368	< 0.05	2.2
22	8.0	.5	180	1	117	170	94	.5	536	< .05	3.4
210	72	6.3	120	4	99	210	120	.1	648	< .05	4.0
87	27	4.6	33	2	100	37	29	.2	256	< .05	2.2
40	12	2.4	30	1	94 (L)	14	4.7	.3	176	< .05	< .03
27	8.0	1.7	48	.8	114 (L)	20	11	.6	216	< .05	< .03
21	10	1.0	43	1	125 (L)	13	2.9	.7	200	< .05	< .03
49	14	3.4	27	1	102 (L)	14	3.1	.3	170	< .05	< .03
28	8.0	1.9	43	.9	112 (L)	17	10	.6	208	< .05	< .03
50	14	3.7	39	1	107 (L)	20	13	.5	224	< .05	< .03
45	16	1.2	28	1	102 (L)	12	2.9	.3	172	< .05	< .03
39	12	2.4	50	2	112 (L)	36	18	.6	268	< .05	1.4
75	24	3.7	47	2	123 (L)	49	25	.4	292	< .05	1.9
99	22	11	42	3	44 (L)	74	57	< .1	288	< .05	4.1
230	84	4.9	140	3	96 (L)	210	160	.3	680	< .05	3.9
48	16	1.9	140	3	63	58	160	.4	428	< .05	2.8
40	12	2.4	85	2	114 (L)	45	59	.6	340	< .05	2.1
220	84	2.4	120	5	101 (L)	220	120	.2	640	< .05	3.6
34	12	1.0	100	3	109 (L)	68	85	.5	372	< .05	< .03
67	21	3.4	24	2	93 (L)	20	13	.2	204	< .05	< .03
26	8.0	1.5	120	2	126 (L)	65	73	.9	396	< .05	< .03
Cycle 2 recovery											
—	—	—	—	—	—	67	72	—	420	—	1.1
—	—	—	—	—	—	64	53	—	316	—	2.9
—	—	—	—	—	—	17	9.4	—	208	—	1.2
—	—	—	—	—	—	71	50	—	308	—	3.3
—	—	—	—	—	—	63	62	—	432	—	1.6
—	—	—	—	—	—	52	63	—	396	—	.95
—	—	—	—	—	—	72	58	—	368	—	3.6
—	—	—	—	—	—	25	20	—	288	—	1.2
—	—	—	—	—	—	74	59	—	372	—	3.6
—	—	—	—	—	—	65	74	—	448	—	1.6
—	—	—	—	—	—	49	57	—	368	—	1.0
—	—	—	—	—	—	75	61	—	376	—	3.6
—	—	—	—	—	—	—	55	—	—	—	—
—	—	—	—	—	—	28	23	—	276	—	1.2
—	—	—	—	—	—	75	59	—	380	—	3.6
—	—	—	—	—	—	—	53	—	—	—	—
—	—	—	—	—	—	67	75	—	440	—	1.6
—	—	—	—	—	—	44	51	—	348	—	1.1
—	—	—	—	—	—	73	58	—	352	—	3.6
—	—	—	—	—	—	28	24	—	252	—	1.3

Table 9. Physical properties and major-ion concentrations in water samples collected during cycles 1 and 2 of the injection, storage, and

Sample collection site (local well name)	Sampling date	Day of cycle phase	Collected by/ analyzed by	Specific conductance (µS/cm)	pH (standard units)	Tempera-ture, water (°C)	Apparent color, unfiltered (units)	Odor threshold at 60°C (TON)	Turbidity (NTU)	Dissolved oxygen (mg/L)
Cycle 2 recovery—Continued										
4-34	05-17-97	4	LAC/LAC	411	6.9	15.0	—	—	0.2	—
4-42	05-17-97	4	LAC/LAC	620	8.6	29.0	—	—	<.1	—
4-13	05-18-97	5	LAC/LAC	438	8.4	25.0	—	—	.1	—
4-33	05-18-97	5	LAC/LAC	330	7.9	22.5	—	—	.2	—
4-42	05-18-97	5	LAC/LAC	616	8.6	28.5	—	—	<.1	—
4-13	05-19-97	6	LAC/LAC	418	8.3	25.0	—	—	.1	—
4-32	05-19-97	6	LAC/LAC	404	6.9	16.0	—	—	1.1	—
4-33	05-19-97	6	LAC/LAC	328	7.9	23.0	—	—	.1	—
4-34	05-19-97	6	LAC/LAC	405	6.9	16.0	—	—	1.1	—
4-42	05-19-97	6	LAC/LAC	614	8.6	28.5	—	—	<.1	—
4-13	05-20-97	7	LAC/LAC	398	8.3	25.0	—	—	.1	—
4-32	05-20-97	7	LAC/LAC	401	7.0	16.0	—	—	.4	—
4-33	05-20-97	7	LAC/LAC	340	8.0	23.0	—	—	.1	—
4-34	05-20-97	7	LAC/LAC	400	6.9	15.5	—	—	.4	—
4-42	05-20-97	7	LAC/LAC	607	8.5	28.0	—	—	<.1	—
4-13	05-21-97	8	LAC/LAC	390	8.3	25.0	—	—	.1	—
4-32	05-21-97	8	LAC/LAC	402	7.0	15.0	—	—	.2	—
4-33	05-21-97	8	LAC/LAC	341	8.0	22.5	—	—	.1	—
4-34	05-21-97	8	LAC/LAC	399	6.9	15.0	—	—	.2	—
4-42	05-21-97	8	LAC/LAC	618	8.5	28.0	—	—	<.1	—
4-13	05-22-97	9	LAC/LAC	379	8.2	24.5	—	—	.2	—
4-32	05-22-97	9	LAC/LAC	395	7.0	15.0	—	—	.2	—
4-32	05-22-97	9	AVEK/AVEK	410 (L)	7.0 (L)	—	—	—	—	—
4-33	05-22-97	9	LAC/LAC	342	8.1	22.5	—	—	.2	—
4-34	05-22-97	9	LAC/LAC	379	6.9	15.0	—	—	.1	—
4-34	05-22-97	9	AVEK/AVEK	400 (L)	7.0 (L)	—	—	—	—	—
4-42	05-22-97	9	LAC/LAC	619	8.5	27.5	—	—	<.1	—
4-13	05-23-97	10	LAC/LAC	377	8.3	24.0	—	—	.2	—
4-32	05-23-97	10	LAC/LAC	392	7.0	15.0	—	—	.2	—
4-33	05-23-97	10	LAC/LAC	335	8.0	22.0	—	—	.1	—
4-34	05-23-97	10	LAC/LAC	376	6.9	15.0	—	—	.1	—
4-42	05-23-97	10	LAC/LAC	617	8.6	27.5	—	—	<.1	—
4-13	05-24-97	11	LAC/LAC	370	8.3	24.0	—	—	.2	—
4-32	05-24-97	11	LAC/LAC	388	7.0	15.0	—	—	.2	—
4-33	05-24-97	11	LAC/LAC	330	8.1	22.0	—	—	.1	—
4-34	05-24-97	11	LAC/LAC	370	6.9	15.0	—	—	.1	—
4-42	05-24-97	11	LAC/LAC	610	8.6	27.0	—	—	<.1	—
4-13	05-25-97	12	LAC/LAC	371	8.3	23.5	—	—	.1	—
4-32	05-25-97	12	LAC/LAC	388	7.0	15.0	—	—	.1	—
4-33	05-25-97	12	LAC/LAC	324	8.2	22.0	—	—	.1	—
4-34	05-25-97	12	LAC/LAC	357	6.9	15.0	—	—	<.1	—
4-42	05-25-97	12	LAC/LAC	608	8.6	27.0	—	—	<.1	—
4-13	05-26-97	13	LAC/LAC	370	8.4	24.0	—	—	.1	—
4-32	05-26-97	13	LAC/LAC	367	7.0	15.0	—	—	.1	—
4-32	05-26-97	13	AVEK/AVEK	380 (L)	7.2 (L)	—	—	—	—	—

recovery study at Lancaster, Antelope Valley, California, March 1995 through January 1998—Continued

Hardness, total (mg/L as CaCO_3)	Calcium, dissolved (mg/L)	Magnesium, dissolved (mg/L)	Sodium, dissolved (mg/L)	Potassium, dissolved (mg/L)	Alkalinity, total (mg/L as CaCO_3)	Sulfate, dissolved (mg/L)	Chloride, dissolved (mg/L)	Fluoride, dissolved (mg/L)	Dissolved solids (mg/L)	Methylene blue active substance (mg/L)	Nitrate (mg/L as NO_3)
Cycle 2 recovery—Continued											
—	—	—	—	—	—	73	57	—	328	—	3.5
—	—	—	—	—	—	67	75	—	432	—	1.7
—	—	—	—	—	—	41	46	—	324	—	1.0
—	—	—	—	—	—	28	23	—	256	—	1.3
—	—	—	—	—	—	66	74	—	432	—	1.7
—	—	—	—	—	—	38	42	—	268	—	1.1
—	—	—	—	—	—	68	55	—	288	—	3.3
—	—	—	—	—	—	27	22	—	208	—	1.4
—	—	—	—	—	—	71	55	—	304	—	3.4
—	—	—	—	—	—	66	73	—	376	—	1.7
—	—	—	—	—	—	34	36	—	256	—	1.1
—	—	—	—	—	—	72	56	—	236	—	3.5
—	—	—	—	—	—	30	26	—	224	—	1.5
—	—	—	—	—	—	71	55	—	248	—	3.3
—	—	—	—	—	—	65	72	—	364	—	1.8
—	—	—	—	—	—	33	34	—	288	—	1.2
—	—	—	—	—	—	68	53	—	312	—	1.9
—	—	—	—	—	—	28	24	—	244	—	1.4
—	—	—	—	—	—	69	52	—	304	—	3.2
—	—	—	—	—	—	65	72	—	408	—	1.8
—	—	—	—	—	—	31	31	—	232	—	1.1
—	—	—	—	—	—	69	52	—	248	—	3.3
—	—	—	—	—	—	—	48	—	—	—	—
—	—	—	—	—	—	27	23	—	132	—	1.5
—	—	—	—	—	—	66	50	—	304	—	3.0
—	—	—	—	—	—	—	47	—	—	—	—
—	—	—	—	—	—	64	72	—	316	—	1.8
—	—	—	—	—	—	30	31	—	188	—	1.2
—	—	—	—	—	—	67	50	—	244	—	3.2
—	—	—	—	—	—	26	21	—	172	—	1.4
—	—	—	—	—	—	64	48	—	228	—	2.8
—	—	—	—	—	—	63	70	—	340	—	1.9
—	—	—	—	—	—	29	29	—	192	—	1.2
—	—	—	—	—	—	65	48	—	192	—	2.9
—	—	—	—	—	—	25	19	—	180	—	1.4
—	—	—	—	—	—	62	46	—	176	—	2.7
—	—	—	—	—	—	62	69	—	336	—	1.8
—	—	—	—	—	—	28	28	—	204	—	1.1
—	—	—	—	—	—	63	47	—	212	—	2.8
—	—	—	—	—	—	18	13	—	160	—	1.0
—	—	—	—	—	—	60	44	—	172	—	2.5
—	—	—	—	—	—	62	69	—	328	—	1.9
—	—	—	—	—	—	28	27	—	200	—	1.1
—	—	—	—	—	—	62	45	—	224	—	2.6
—	—	—	—	—	—	—	—	—	—	—	—

Table 9. Physical properties and major-ion concentrations in water samples collected during cycles 1 and 2 of the injection, storage, and

Sample collection site (local well name)	Sampling date	Day of cycle phase	Collected by/ analyzed by	Specific conductance ($\mu\text{S}/\text{cm}$)	pH (standard units)	Tempera-ture, water ($^{\circ}\text{C}$)	Apparent color, unfiltered (units)	Odor threshold at 60°C (TON)	Turbidity (NTU)	Dissolved oxygen (mg/L)
Cycle 2 recovery—Continued										
4-33	05-26-97	13	LAC/LAC	325	8.2	22.0	—	—	0.1	—
4-34	05-26-97	13	LAC/LAC	352	6.9	14.5	—	—	.1	—
4-42	05-26-97	13	LAC/LAC	612	8.6	26.5	—	—	<.1	—
4-13	05-27-97	14	LAC/LAC	348	8.2	24.0	—	—	.1	—
4-32	05-27-97	14	LAC/LAC	352	7.0	15.0	—	—	.2	—
4-33	05-27-97	14	LAC/LAC	312	8.0	22.5	—	—	.1	—
4-34	05-27-97	14	LAC/LAC	340	6.9	15.0	—	—	.1	—
4-42	05-27-97	14	LAC/LAC	590	8.5	27.0	—	—	<.1	—
4-13	05-28-97	15	LAC/LAC	350	8.3	24.5	—	—	.2	—
4-32	05-28-97	15	LAC/LAC	344	6.9	15.0	—	—	.1	—
4-33	05-28-97	15	LAC/LAC	307	8.0	22.5	—	—	.1	—
4-34	05-28-97	15	LAC/LAC	336	6.9	15.0	—	—	.1	—
4-42	05-28-97	15	LAC/LAC	585	8.5	27.5	—	—	<.1	—
4-13	05-29-97	16	LAC/LAC	344	8.1	24.5	—	—	.2	—
4-32	05-29-97	16	LAC/LAC	338	6.9	15.0	—	—	.1	—
4-32	05-29-97	16	AVEK/AVEK	350 (L)	7.1 (L)	—	—	—	—	—
4-33	05-29-97	16	LAC/LAC	299	8.0	22.0	—	—	.1	—
4-34	05-29-97	16	LAC/LAC	331	6.9	15.0	—	—	.1	—
4-34	05-29-97	16	AVEK/AVEK	340 (L)	7.1 (L)	—	—	—	—	—
4-42	05-29-97	16	LAC/LAC	567	8.5	27.0	—	—	<.1	—
4-13	05-30-97	17	LAC/LAC	337	8.2	24.5	—	—	.1	—
4-32	05-30-97	17	LAC/LAC	332	7.0	15.0	—	—	.1	—
4-33	05-30-97	17	LAC/LAC	296	8.0	22.5	—	—	<.1	—
4-34	05-30-97	17	LAC/LAC	324	6.9	15.0	—	—	.1	—
4-42	05-30-97	17	LAC/LAC	556	8.5	27.5	—	—	<.1	—
4-13	05-31-97	18	LAC/LAC	340	8.2	24.5	—	—	.2	—
4-32	05-31-97	18	LAC/LAC	330	7.0	15.0	—	—	.1	—
4-33	05-31-97	18	LAC/LAC	297	8.1	22.0	—	—	<.1	—
4-34	05-31-97	18	LAC/LAC	325	7.0	15.0	—	—	.1	—
4-42	05-31-97	18	LAC/LAC	550	8.5	27.5	—	—	<.1	—
4-13	06-01-97	19	LAC/LAC	335	8.3	24.5	—	—	.1	—
4-32	06-01-97	19	LAC/LAC	335	7.0	15.0	—	—	.1	—
4-33	06-01-97	19	LAC/LAC	299	8.2	22.0	—	—	<.1	—
4-34	06-01-97	19	LAC/LAC	324	7.0	15.0	—	—	<.1	—
4-42	06-01-97	19	LAC/LAC	552	8.5	26.5	—	—	<.1	—
4-13	06-02-97	20	LAC/LAC	340	8.2	24.0	—	—	.1	—
4-32	06-02-97	20	LAC/LAC	328	7.1	15.0	—	—	.1	—
4-33	06-02-97	20	LAC/LAC	293	8.1	22.0	—	—	<.1	—
4-34	06-02-97	20	LAC/LAC	324	7.0	15.0	—	—	.1	—
4-42	06-02-97	20	LAC/LAC	542	8.5	26.5	—	—	<.1	—
4-13	06-03-97	21	LAC/LAC	342	8.2	24.5	—	—	.1	—
4-32	06-03-97	21	LAC/LAC	325	7.1	15.0	—	—	.1	—
4-33	06-03-97	21	LAC/LAC	293	8.1	22.5	—	—	<.1	—
4-34	06-03-97	21	LAC/LAC	324	7.0	15.0	—	—	.1	—
4-42	06-03-97	21	LAC/LAC	536	8.5	27.0	—	—	<.1	—

recovery study at Lancaster, Antelope Valley, California, March 1995 through January 1998—Continued

Hardness, total (mg/L as CaCO_3)	Calcium, dissolved (mg/L)	Magnesium, dissolved (mg/L)	Sodium, dissolved (mg/L)	Potassium, dissolved (mg/L)	Alkalinity, total (mg/L as CaCO_3)	Sulfate, dissolved (mg/L)	Chloride, dissolved (mg/L)	Fluoride, dissolved (mg/L)	Dissolved, solids (mg/L)	Methylene blue active substance (mg/L)	Nitrate (mg/L as NO_3)
Cycle 2 recovery—Continued											
—	—	—	—	—	23	17	—	184	—	—	1.4
—	—	—	—	—	59	43	—	196	—	—	2.4
—	—	—	—	—	61	68	—	356	—	—	2.0
—	—	—	—	—	26	25	—	184	—	—	1.1
—	—	—	—	—	57	43	—	220	—	—	2.5
—	—	—	—	—	22	16	—	192	—	—	1.3
—	—	—	—	—	54	41	—	204	—	—	2.2
—	—	—	—	—	57	64	—	352	—	—	2.0
—	—	—	—	—	25	24	—	204	—	—	1.1
—	—	—	—	—	56	42	—	180	—	—	2.2
—	—	—	—	—	21	15	—	188	—	—	1.4
—	—	—	—	—	53	41	—	180	—	—	2.1
—	—	—	—	—	57	63	—	324	—	—	2.1
—	—	—	—	—	25	24	—	222	—	—	1.1
—	—	—	—	—	55	41	—	210	—	—	2.2
—	—	—	—	—	—	40	—	—	—	—	—
—	—	—	—	—	21	15	—	194	—	—	1.4
—	—	—	—	—	53	41	—	206	—	—	2.0
—	—	—	—	—	—	39	—	—	—	—	—
—	—	—	—	—	56	61	—	344	—	—	2.1
—	—	—	—	—	25	23	—	212	—	—	1.1
—	—	—	—	—	54	40	—	204	—	—	2.1
—	—	—	—	—	21	14	—	200	—	—	1.4
—	—	—	—	—	52	40	—	224	—	—	2.0
—	—	—	—	—	55	60	—	340	—	—	2.3
—	—	—	—	—	25	22	—	228	—	—	1.1
—	—	—	—	—	53	40	—	236	—	—	2.0
—	—	—	—	—	21	14	—	208	—	—	1.4
—	—	—	—	—	51	40	—	192	—	—	1.9
—	—	—	—	—	54	59	—	360	—	—	2.2
—	—	—	—	—	24	22	—	232	—	—	1.1
—	—	—	—	—	52	40	—	236	—	—	2.0
—	—	—	—	—	21	13	—	200	—	—	1.4
—	—	—	—	—	51	40	—	228	—	—	1.8
—	—	—	—	—	53	57	—	348	—	—	2.3
—	—	—	—	—	24	22	—	236	—	—	1.1
—	—	—	—	—	52	40	—	210	—	—	1.9
—	—	—	—	—	20	13	—	202	—	—	1.4
—	—	—	—	—	50	41	—	212	—	—	1.7
—	—	—	—	—	52	56	—	344	—	—	2.4
—	—	—	—	—	24	21	—	206	—	—	1.1
—	—	—	—	—	51	40	—	190	—	—	1.8
—	—	—	—	—	20	12	—	188	—	—	1.4
—	—	—	—	—	49	41	—	206	—	—	1.7
—	—	—	—	—	51	54	—	322	—	—	2.3

Table 9. Physical properties and major-ion concentrations in water samples collected during cycles 1 and 2 of the injection, storage, and

Sample collection site (local well name)	Sampling date	Day of cycle phase	Collected by/ analyzed by	Specific conductance ($\mu\text{S}/\text{cm}$)	pH (standard units)	Temperature, water ($^{\circ}\text{C}$)	Apparent color, unfiltered (units)	Odor threshold at 60°C (TON)	Turbidity (NTU)	Dissolved oxygen (mg/L)
Cycle 2 recovery—Continued										
4-13	06-04-97	22	LAC/LAC	330	8.4	24.0	—	—	0.1	—
4-32	06-04-97	22	LAC/LAC	328	7.0	15.0	—	—	.1	—
4-33	06-04-97	22	LAC/LAC	289	8.2	22.5	—	—	.1	—
4-34	06-04-97	22	LAC/LAC	324	7.0	15.0	—	—	<.1	—
4-42	06-04-97	22	LAC/LAC	516	8.5	26.5	—	—	<.1	—
4-13	06-05-97	23	LAC/LAC	345	8.4	24.0	—	—	.1	—
4-32	06-05-97	23	LAC/LAC	326	7.0	14.5	—	—	.1	—
4-32	06-05-97	23	AVEK/AVEK	340 (L)	7.1 (L)	—	—	—	—	—
4-33	06-05-97	23	LAC/LAC	288	8.2	21.5	—	—	<.1	—
4-34	06-05-97	23	LAC/LAC	334	7.0	14.5	—	—	.1	—
4-34	06-05-97	23	AVEK/AVEK	340 (L)	7.2 (L)	—	—	—	—	—
4-42	06-05-97	23	LAC/LAC	529	8.5	26.0	—	—	<.1	—
4-13	06-06-97	24	LAC/LAC	339	8.4	24.0	—	—	.1	—
4-32	06-06-97	24	LAC/LAC	321	7.0	15.0	—	—	.1	—
4-33	06-06-97	24	LAC/LAC	289	8.2	22.5	—	—	.1	—
4-34	06-06-97	24	LAC/LAC	332	7.0	15.0	—	—	.2	—
4-42	06-06-97	24	LAC/LAC	512	8.6	26.0	—	—	.1	—
4-13	06-07-97	25	LAC/LAC	329	8.4	24.0	—	—	.2	—
4-32	06-07-97	25	LAC/LAC	319	7.1	15.0	—	—	.1	—
4-33	06-07-97	25	LAC/LAC	287	8.2	22.5	—	—	.1	—
4-34	06-07-97	25	LAC/LAC	331	7.0	15.0	—	—	.1	—
4-42	06-07-97	25	LAC/LAC	515	8.5	26.5	—	—	<.1	—
4-13	06-08-97	26	LAC/LAC	334	8.4	23.5	—	—	.1	—
4-32	06-08-97	26	LAC/LAC	323	7.1	15.0	—	—	.1	—
4-33	06-08-97	26	LAC/LAC	290	8.2	22.0	—	—	<.1	—
4-34	06-08-97	26	LAC/LAC	342	7.1	15.0	—	—	.1	—
4-42	06-08-97	26	LAC/LAC	512	8.5	26.0	—	—	<.1	—
4-13	06-09-97	27	LAC/LAC	323	8.4	25.0	—	—	.2	—
4-32	06-09-97	27	LAC/LAC	326	7.3	14.5	—	—	.3	—
4-33	06-09-97	27	LAC/LAC	283	8.3	22.0	—	—	<.1	—
4-34	06-09-97	27	LAC/LAC	340	7.2	15.0	—	—	.1	—
4-42	06-09-97	27	LAC/LAC	507	8.5	26.0	—	—	<.1	—
4-13	06-10-97	28	LAC/LAC	325	8.3	25.0	—	—	.1	—
4-32	06-10-97	28	LAC/LAC	324	7.1	15.0	—	—	.1	—
4-33	06-10-97	28	LAC/LAC	278	8.2	21.0	—	—	.1	—
4-34	06-10-97	28	LAC/LAC	347	7.1	15.0	—	—	.1	—
4-42	06-10-97	28	LAC/LAC	502	8.5	26.0	—	—	.2	—
4-13	06-11-97	29	LAC/LAC	320	8.2	25.0	—	—	.1	—
4-32	06-11-97	29	LAC/LAC	322	7.1	15.0	—	—	.2	—
4-33	06-11-97	29	LAC/LAC	276	8.2	24.0	—	—	<.1	—
4-34	06-11-97	29	LAC/LAC	346	7.1	15.0	—	—	.1	—
4-42	06-11-97	29	LAC/LAC	498	8.5	27.0	—	—	<.1	—
4-13	06-12-97	30	LAC/LAC	322	8.2	24.0	0	0	<.1	—
4-32	06-12-97	30	LAC/LAC	324	7.1	15.0	—	—	<.1	—
4-32	06-12-97	30	AVEK/AVEK	340 (L)	7.2 (L)	—	—	—	—	—

recovery study at Lancaster, Antelope Valley, California, March 1995 through January 1998—Continued

Hardness, total (mg/L as CaCO_3)	Calcium, dissolved (mg/L)	Magnesium, dissolved (mg/L)	Sodium, dissolved (mg/L)	Potassium, dissolved (mg/L)	Alkalinity, total (mg/L as CaCO_3)	Sulfate, dissolved (mg/L)	Chloride, dissolved (mg/L)	Fluoride, dissolved (mg/L)	Dissolved, solids (mg/L)	Methylene blue active substance (mg/L)	Nitrate (mg/L as NO_3)
Cycle 2 recovery—Continued											
—	—	—	—	—	—	24	21	—	236	—	1.1
—	—	—	—	—	—	51	40	—	220	—	1.7
—	—	—	—	—	—	20	12	—	220	—	1.4
—	—	—	—	—	—	49	41	—	226	—	1.6
—	—	—	—	—	—	50	53	—	348	—	2.3
—	—	—	—	—	—	24	21	—	210	—	1.1
—	—	—	—	—	—	50	40	—	182	—	1.8
—	—	—	—	—	—	—	40	—	—	—	—
—	—	—	—	—	—	20	11	—	264	—	1.5
—	—	—	—	—	—	49	43	—	206	—	1.7
—	—	—	—	—	—	—	37	—	—	—	—
—	—	—	—	—	—	50	53	—	312	—	2.5
—	—	—	—	—	—	24	21	—	234	—	1.1
—	—	—	—	—	—	50	40	—	206	—	1.7
—	—	—	—	—	—	19	11	—	222	—	1.5
—	—	—	—	—	—	49	44	—	220	—	1.6
—	—	—	—	—	—	49	52	—	326	—	2.5
—	—	—	—	—	—	23	19	—	216	—	1.1
—	—	—	—	—	—	49	41	—	206	—	1.6
—	—	—	—	—	—	19	10	—	204	—	1.5
—	—	—	—	—	—	48	44	—	228	—	1.6
—	—	—	—	—	—	48	50	—	348	—	2.5
—	—	—	—	—	—	23	19	—	228	—	1.1
—	—	—	—	—	—	47	40	—	214	—	1.6
—	—	—	—	—	—	18	10	—	206	—	1.5
—	—	—	—	—	—	47	45	—	238	—	1.5
—	—	—	—	—	—	47	50	—	302	—	2.5
—	—	—	—	—	—	23	19	—	210	—	1.2
—	—	—	—	—	—	48	42	—	190	—	1.6
—	—	—	—	—	—	19	10	—	208	—	1.7
—	—	—	—	—	—	48	46	—	212	—	1.6
—	—	—	—	—	—	48	50	—	330	—	2.6
—	—	—	—	—	—	23	19	—	218	—	1.1
—	—	—	—	—	—	47	42	—	190	—	1.5
—	—	—	—	—	—	18	9.5	—	208	—	1.4
—	—	—	—	—	—	48	46	—	204	—	1.5
—	—	—	—	—	—	47	48	—	306	—	2.4
—	—	—	—	—	—	24	20	—	208	—	1.2
—	—	—	—	—	—	49	45	—	192	—	1.7
—	—	—	—	—	—	19	9.8	—	188	—	1.6
—	—	—	—	—	—	50	49	—	204	—	1.7
—	—	—	—	—	—	48	49	—	302	—	2.7
23	8.8	0.2	60	1	107 (L)	26	21	0.4	234	< 0.05	1.2
—	—	—	—	—	—	49	46	—	248	—	1.7
—	—	—	—	—	—	—	40	—	—	—	—

Table 9. Physical properties and major-ion concentrations in water samples collected during cycles 1 and 2 of the injection, storage, and

Sample collection site (local well name)	Sampling date	Day of cycle phase	Collected by/ analyzed by	Specific conductance ($\mu\text{S}/\text{cm}$)	pH (standard units)	Temperature, water ($^{\circ}\text{C}$)	Apparent color, unfiltered (units)	Odor threshold at 60°C (TON)	Turbidity (NTU)	Dissolved oxygen (mg/L)
Cycle 2 recovery—Continued										
4-33	06-12-97	30	LAC/LAC	278	8.1	24.0	0	0	0.1	—
4-34	06-12-97	30	LAC/LAC	342	7.0	15.0	—	—	.1	—
4-34	06-12-97	30	AVEK/AVEK	350 (L)	7.2 (L)	—	—	—	—	—
4-42	06-12-97	30	LAC/LAC	502	8.5	27.0	0	0	<.1	—
4-13	06-13-97	31	LAC/LAC	319	8.3	24.0	—	—	.1	—
4-32	06-13-97	31	LAC/LAC	327	7.1	15.0	—	—	.1	—
4-33	06-13-97	31	LAC/LAC	269	8.2	22.0	—	—	.2	—
4-34	06-13-97	31	LAC/LAC	340	7.0	16.0	—	—	.1	—
4-42	06-13-97	31	LAC/LAC	486	8.5	25.0	—	—	<.1	—
4-13	06-14-97	32	LAC/LAC	330	8.3	23.0	—	—	.1	—
4-32	06-14-97	32	LAC/LAC	334	7.1	15.0	—	—	.1	—
4-33	06-14-97	32	LAC/LAC	279	8.2	22.0	—	—	.1	—
4-34	06-14-97	32	LAC/LAC	354	7.1	15.0	—	—	<.1	—
4-42	06-14-97	32	LAC/LAC	491	8.5	26.0	—	—	<.1	—
4-13	06-15-97	33	LAC/LAC	332	8.2	26.5	—	—	.1	—
4-32	06-15-97	33	LAC/LAC	334	7.0	15.0	—	—	.1	—
4-33	06-15-97	33	LAC/LAC	282	8.1	23.5	—	—	<.1	—
4-34	06-15-97	33	LAC/LAC	353	6.9	15.0	—	—	.1	—
4-42	06-15-97	33	LAC/LAC	496	8.4	22.5	—	—	<.1	—
4-32	06-16-97	34	LAC/LAC	334	7.1	18.0	—	—	.1	—
4-34	06-16-97	34	LAC/LAC	349	7.1	20.0	—	—	.2	—
4-32	06-19-97	37	AVEK/AVEK	360 (L)	7.3 (L)	—	—	—	—	—
4-34	06-19-97	37	AVEK/AVEK	380 (L)	7.2 (L)	—	—	—	—	—
4-32	06-24-97	42	LAC/LAC	346	7.1	16.0	—	—	.1	—
4-34	06-24-97	42	LAC/LAC	358	7.1	16.0	—	—	.1	—
4-32	06-26-97	44	AVEK/AVEK	380 (L)	7.2 (L)	—	—	—	—	—
4-34	06-26-97	44	AVEK/AVEK	380 (L)	7.2 (L)	—	—	—	—	—
4-32	07-01-97	49	LAC/LAC	356	7.1	16.0	—	—	.1	—
4-34	07-01-97	49	LAC/LAC	364	7.1	16.0	—	—	.1	—
4-32	07-03-97	51	AVEK/AVEK	380 (L)	7.3 (L)	—	—	—	—	—
4-34	07-03-97	51	AVEK/AVEK	390 (L)	7.3 (L)	—	—	—	—	—
4-13	07-08-97	56	LAC/LAC	315	8.2	24.0	—	—	.2	—
4-32	07-08-97	56	LAC/LAC	358	7.2	16.0	—	—	.1	—
4-33	07-08-97	56	LAC/LAC	290	8.1	23.0	—	—	<.1	—
4-34	07-08-97	56	LAC/LAC	367	7.1	16.5	—	—	.1	—
4-42	07-08-97	56	LAC/LAC	536	8.4	27.0	—	—	.2	—
4-32	07-10-97	58	AVEK/AVEK	380 (L)	7.4 (L)	—	—	—	—	—
4-34	07-10-97	58	AVEK/AVEK	390 (L)	7.4 (L)	—	—	—	—	—
4-32	07-15-97	63	LAC/LAC	362	7.2	16.5	—	—	.1	—
4-34	07-15-97	63	LAC/LAC	368	7.1	16.5	—	—	.1	—
4-32	07-17-97	65	AVEK/AVEK	380 (L)	7.5 (L)	—	—	—	—	—
4-34	07-17-97	65	AVEK/AVEK	390 (L)	7.5 (L)	—	—	—	—	—
4-32	07-23-97	71	LAC/LAC	359	7.4	17.0	—	—	.1	—
4-34	07-23-97	71	LAC/LAC	365	7.3	17.5	—	—	.1	—
4-32	07-24-97	72	AVEK/AVEK	380 (L)	7.5 (L)	—	—	—	—	—

recovery study at Lancaster, Antelope Valley, California, March 1995 through January 1998—Continued

Hardness, total (mg/L as CaCO_3)	Calcium, dissolved (mg/L)	Magnesium, dissolved (mg/L)	Sodium, dissolved (mg/L)	Potassium, dissolved (mg/L)	Alkalinity, total (mg/L as CaCO_3)	Sulfate, dissolved (mg/L)	Chloride, dissolved (mg/L)	Fluoride, dissolved (mg/L)	Dissolved, solids (mg/L)	Methylene blue active substance (mg/L)	Nitrate (mg/L as NO_3)
Cycle 2 recovery—Continued											
37	15	< 0.1	46	1	102 (L)	18	9.7	0.5	202	< 0.05	1.6
—	—	—	—	—	—	49	50	—	222	—	1.8
—	—	—	—	—	—	—	44	—	—	—	—
25	9.6	.2	91	2	118 (L)	47	49	.7	332	< .05	2.8
—	—	—	—	—	—	24	20	—	230	—	1.2
70	11	10	38	3	38 (L)	49	47	—	248	—	1.7
—	—	—	—	—	—	18	9.4	—	202	—	1.6
—	—	—	—	—	—	49	51	—	228	—	1.8
—	—	—	—	—	—	47	49	—	316	—	2.9
—	—	—	—	—	—	23	19	—	226	—	1.2
—	—	—	—	—	—	48	47	—	216	—	1.7
—	—	—	—	—	—	18	9.1	—	202	—	1.7
—	—	—	—	—	—	49	50	—	230	—	1.8
—	—	—	—	—	—	46	47	—	324	—	2.8
—	—	—	—	—	—	23	19	—	248	—	1.2
—	—	—	—	—	—	48	48	—	230	—	1.7
—	—	—	—	—	—	18	9.0	—	230	—	1.6
—	—	—	—	—	—	49	51	—	260	—	1.9
—	—	—	—	—	—	46	47	—	332	—	2.8
—	—	—	—	—	—	48	49	—	226	—	1.7
—	—	—	—	—	—	49	52	—	224	—	1.8
—	—	—	—	—	—	—	47	—	—	—	—
—	—	—	—	—	—	—	48	—	—	—	—
—	—	—	—	—	—	47	54	—	252	—	1.9
—	—	—	—	—	—	48	54	—	254	—	2.1
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	45	60	—	238	—	2.1
—	—	—	—	—	—	45	59	—	244	—	2.2
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	20	16	—	202	—	1.4
—	—	—	—	—	—	44	54	—	236	—	2.2
—	—	—	—	—	—	23	12	—	194	—	1.6
—	—	—	—	—	—	45	45	—	244	—	2.2
—	—	—	—	—	—	53	58	—	342	—	< .03
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	42	51	—	226	—	2.2
—	—	—	—	—	—	44	47	—	238	—	2.1
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	41	48	—	218	—	2.2
—	—	—	—	—	—	43	46	—	222	—	2.2
—	—	—	—	—	—	—	—	—	—	—	—

Table 9. Physical properties and major-ion concentrations in water samples collected during cycles 1 and 2 of the injection, storage, and

Sample collection site (local well name)	Sampling date	Day of cycle phase	Collected by/ analyzed by	Specific conductance ($\mu\text{S}/\text{cm}$)	pH (standard units)	Temperature, water ($^{\circ}\text{C}$)	Apparent color, unfiltered (units)	Odor threshold at 60°C (TON)	Turbidity (NTU)	Dissolved oxygen (mg/L)
Cycle 2 recovery—Continued										
4-34	07-24-97	72	AVEK/AVEK	390 (L)	7.5 (L)	—	—	—	—	—
4-32	07-29-97	77	LAC/LAC	357	7.3	17.5	—	—	0.1	—
4-34	07-29-97	77	LAC/LAC	364	7.3	18.0	—	—	.1	—
4-32	07-31-97	79	AVEK/AVEK	370 (L)	7.5 (L)	—	—	—	—	—
4-34	07-31-97	79	AVEK/AVEK	390 (L)	7.6 (L)	—	—	—	—	—
4-32	08-05-97	84	LAC/LAC	349	7.4	18.0	—	—	.1	—
4-34	08-05-97	84	LAC/LAC	357	7.3	18.0	—	—	.1	—
4-32	08-07-97	86	AVEK/AVEK	360 (L)	7.6 (L)	—	—	—	—	—
4-34	08-07-97	86	AVEK/AVEK	380 (L)	7.6 (L)	—	—	—	—	—
4-13	08-12-97	91	LAC/LAC	308	8.2	23.0	—	—	.1	—
4-32	08-12-97	91	LAC/LAC	343	7.4	17.5	—	—	.1	—
4-34	08-12-97	91	LAC/LAC	360	7.4	18.0	—	—	.1	—
4-42	08-12-97	91	LAC/LAC	451	8.3	25.0	—	—	.1	—
4-32	08-14-97	93	AVEK/AVEK	360 (L)	7.6 (L)	—	—	—	—	—
4-34	08-14-97	93	AVEK/AVEK	380 (L)	7.6 (L)	—	—	—	—	—
4-32	08-19-97	98	LAC/LAC	338	7.4	18.0	—	—	.1	—
4-34	08-19-97	98	LAC/LAC	359	7.4	18.5	—	—	.1	—
4-32	08-21-97	100	AVEK/AVEK	350 (L)	7.7 (L)	—	—	—	—	—
4-34	08-21-97	100	AVEK/AVEK	380 (L)	7.6 (L)	—	—	—	—	—
4-32	08-26-97	105	LAC/LAC	330	7.3	18.0	—	—	.1	—
4-34	08-26-97	105	LAC/LAC	356	7.3	16.0	—	—	.1	—
4-32	08-28-97	107	AVEK/AVEK	340 (L)	7.7 (L)	—	—	—	—	—
4-34	08-28-97	107	AVEK/AVEK	390 (L)	7.7 (L)	—	—	—	—	—
4-32	09-02-97	112	LAC/LAC	328	7.3	18.0	—	—	.1	—
4-34	09-02-97	112	LAC/LAC	357	7.3	18.5	—	—	.1	—
4-32	09-04-97	114	AVEK/AVEK	340 (L)	7.8 (L)	—	—	—	—	—
4-34	09-04-97	114	AVEK/AVEK	380 (L)	7.8 (L)	—	—	—	—	—
4-13	09-09-97	119	LAC/LAC	294	8.2	23.5	—	—	.1	—
4-32	09-09-97	119	LAC/LAC	326	7.6	19.0	—	—	.1	—
4-34	09-09-97	119	LAC/LAC	365	7.6	19.5	—	—	.1	—
4-42	09-09-97	119	LAC/LAC	436	8.4	25.0	—	—	.1	—
4-32	09-11-97	121	AVEK/AVEK	330 (L)	7.7 (L)	—	—	—	—	—
4-34	09-11-97	121	AVEK/AVEK	380 (L)	7.8 (L)	—	—	—	—	—
4-32	09-16-97	126	LAC/LAC	322	7.6	19.0	—	—	.1	—
4-33	09-16-97	126	LAC/LAC	251	8.1	22.0	—	—	.1	—
4-34	09-16-97	126	LAC/LAC	365	7.6	19.0	—	—	.1	—
4-32	09-18-97	128	AVEK/AVEK	330 (L)	7.8 (L)	—	—	—	—	—
4-34	09-18-97	128	AVEK/AVEK	390 (L)	7.8 (L)	—	—	—	—	—
4-32	09-24-97	134	LAC/LAC	318	7.6	19.0	—	—	.1	—
4-34	09-24-97	134	LAC/LAC	369	7.6	20.0	—	—	.1	—
4-32	09-25-97	135	AVEK/AVEK	320 (L)	7.8 (L)	—	—	—	—	—
4-34	09-25-97	135	AVEK/AVEK	380 (L)	7.8 (L)	—	—	—	—	—
4-32	10-01-97	141	LAC/LAC	314	7.6	19.0	—	—	.1	—
4-34	10-01-97	141	LAC/LAC	362	7.6	20.0	—	—	.1	—
4-32	10-02-97	142	AVEK/AVEK	320 (L)	7.8 (L)	—	—	—	—	—

recovery study at Lancaster, Antelope Valley, California, March 1995 through January 1998—Continued

Hardness, total (mg/L as CaCO_3)	Calcium, dissolved (mg/L)	Magnesium, dissolved (mg/L)	Sodium, dissolved (mg/L)	Potassium, dissolved (mg/L)	Alkalinity, total (mg/L as CaCO_3)	Sulfate, dissolved (mg/L)	Chloride, dissolved (mg/L)	Fluoride, dissolved (mg/L)	Dissolved, solids (mg/L)	Methylene blue active substance (mg/L)	Nitrate (mg/L as NO_3)
Cycle 2 recovery—Continued											
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	38	44	—	202	—	—	2.2
—	—	—	—	—	40	42	—	204	—	—	2.1
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	36	40	—	206	—	—	2.2
—	—	—	—	—	40	39	—	218	—	—	2.0
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	21	16	—	190	—	—	1.1
—	—	—	—	—	35	37	—	212	—	—	2.1
—	—	—	—	—	40	37	—	230	—	—	2.0
—	—	—	—	—	40	38	—	286	—	—	2.6
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	28	29	—	222	—	—	1.8
—	—	—	—	—	33	30	—	244	—	—	1.8
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	28	28	—	202	—	—	2.0
—	—	—	—	—	35	31	—	228	—	—	1.9
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	27	25	—	214	—	—	1.8
—	—	—	—	—	35	29	—	236	—	—	1.9
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	19	14	—	202	—	—	.99
—	—	—	—	—	27	24	—	216	—	—	2.0
—	—	—	—	—	36	29	—	238	—	—	2.0
—	—	—	—	—	36	35	—	280	—	—	2.3
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	26	22	—	202	—	—	2.0
—	—	—	—	—	15	5.7	—	172	—	—	1.3
—	—	—	—	—	36	28	—	240	—	—	1.9
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	26	21	—	206	—	—	2.4
—	—	—	—	—	36	27	—	234	—	—	2.1
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	26	20	—	200	—	—	2.3
—	—	—	—	—	36	27	—	234	—	—	2.2
—	—	—	—	—	—	—	—	—	—	—	—

Table 9. Physical properties and major-ion concentrations in water samples collected during cycles 1 and 2 of the injection, storage, and

Sample collection site (local well name)	Sampling date	Day of cycle phase	Collected by/ analyzed by	Specific conductance ($\mu\text{S}/\text{cm}$)	pH (standard units)	Temperature, water ($^{\circ}\text{C}$)	Apparent color, unfiltered (units)	Odor threshold at 60°C (TON)	Turbidity (NTU)	Dissolved oxygen (mg/L)
Cycle 2 recovery—Continued										
4-34	10-02-97	142	AVEK/AVEK	380 (L)	7.9 (L)	—	—	—	—	—
4-32	10-08-97	148	LAC/LAC	315	7.6	19.0	—	—	0.1	—
4-34	10-08-97	148	LAC/LAC	364	7.6	20.0	—	—	.1	—
4-32	10-09-97	149	AVEK/AVEK	330 (L)	8.0 (L)	—	—	—	—	—
4-34	10-09-97	149	AVEK/AVEK	390 (L)	8.0 (L)	—	—	—	—	—
4-13	10-14-97	154	LAC/LAC	294	8.1	23.0	—	—	.1	—
4-32	10-14-97	154	LAC/LAC	309	7.5	19.0	—	—	.1	—
4-33	10-14-97	154	LAC/LAC	256	8.0	22.0	—	—	.1	—
4-34	10-14-97	154	LAC/LAC	368	7.6	19.5	—	—	.1	—
4-42	10-14-97	154	LAC/LAC	443	8.2	25.0	—	—	.1	—
4-32	10-16-97	156	AVEK/AVEK	320 (L)	7.9 (L)	—	—	—	—	—
4-34	10-16-97	156	AVEK/AVEK	390 (L)	8.0 (L)	—	—	—	—	—
4-32	10-21-97	161	LAC/LAC	318	7.5	19.5	—	—	.1	—
4-34	10-21-97	161	LAC/LAC	382	7.6	20.0	—	—	.1	—
4-32	10-23-97	163	AVEK/AVEK	320 (L)	8.0 (L)	—	—	—	—	—
4-34	10-23-97	163	AVEK/AVEK	390 (L)	8.1 (L)	—	—	—	—	—
4-32	10-29-97	169	LAC/LAC	315	7.7	20.0	—	—	.1	—
4-34	10-29-97	169	LAC/LAC	384	7.7	20.0	—	—	.1	—
4-32	10-30-97	170	AVEK/AVEK	320 (L)	8.0 (L)	—	—	—	—	—
4-34	10-30-97	170	AVEK/AVEK	380 (L)	8.0 (L)	—	—	—	—	—
4-32	11-05-97	176	LAC/LAC	310	7.8	20.0	—	—	.1	—
4-34	11-05-97	176	LAC/LAC	380	7.8	20.0	—	—	.1	—
4-32	11-06-97	177	AVEK/AVEK	320 (L)	8.0 (L)	—	—	—	—	—
4-34	11-06-97	177	AVEK/AVEK	390 (L)	8.0 (L)	—	—	—	—	—
4-13	11-12-97	183	LAC/LAC	244	8.0	21.0	—	—	1.8	—
4-32	11-12-97	183	LAC/LAC	320	7.7	19.5	—	—	.1	—
4-33	11-12-97	183	LAC/LAC	258	8.0	20.0	—	—	.6	—
4-34	11-12-97	183	LAC/LAC	396	7.7	20.0	—	—	.1	—
4-42	11-12-97	183	LAC/LAC	537	8.3	25.0	—	—	1.7	—
4-32	11-13-97	184	AVEK/AVEK	320 (L)	8.1 (L)	—	—	—	—	—
4-34	11-13-97	184	AVEK/AVEK	390 (L)	8.0 (L)	—	—	—	—	—
4-32	11-19-97	190	LAC/LAC	312	7.8	20.0	—	—	.1	—
4-34	11-19-97	190	LAC/LAC	389	7.8	20.0	—	—	.1	—
4-32	11-20-97	191	AVEK/AVEK	320 (L)	8.1 (L)	—	—	—	—	—
4-34	11-20-97	191	AVEK/AVEK	390 (L)	8.1 (L)	—	—	—	—	—
4-32	11-26-97	197	LAC/LAC	314	7.8	20.0	—	—	.1	—
4-34	11-26-97	197	LAC/LAC	389	7.7	20.0	—	—	.1	—
4-32	11-26-97	197	AVEK/AVEK	320 (L)	8.0 (L)	—	—	—	—	—
4-34	11-26-97	197	AVEK/AVEK	390 (L)	8.0 (L)	—	—	—	—	—
4-32	12-03-97	204	LAC/LAC	323	7.8	20.0	—	—	.1	—
4-34	12-03-97	204	LAC/LAC	402	7.7	20.0	—	—	<.1	—
4-32	12-04-97	205	AVEK/AVEK	320 (L)	8.1 (L)	—	—	—	—	—
4-34	12-04-97	205	AVEK/AVEK	380 (L)	8.0 (L)	—	—	—	—	—
4-13	12-10-97	211	LAC/LAC	289	7.9	22.0	—	—	.3	—
4-32	12-10-97	211	LAC/LAC	311	7.7	20.0	—	—	.1	—

recovery study at Lancaster, Antelope Valley, California, March 1995 through January 1998—Continued

Hardness, total (mg/L as CaCO_3)	Calcium, dissolved (mg/L)	Magnesium, dissolved (mg/L)	Sodium, dissolved (mg/L)	Potassium, dissolved (mg/L)	Alkalinity, total (mg/L as CaCO_3)	Sulfate, dissolved (mg/L)	Chloride, dissolved (mg/L)	Fluoride, dissolved (mg/L)	Dissolved, solids (mg/L)	Methylene blue active substance (mg/L)	Nitrate (mg/L as NO_3)
Cycle 2 recovery—Continued											
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	25	19	—	200	—	2.4
—	—	—	—	—	—	37	27	—	240	—	2.2
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	20	15	—	178	—	1.1
—	—	—	—	—	—	24	17	—	186	—	2.3
—	—	—	—	—	—	15	5.6	—	160	—	1.4
—	—	—	—	—	—	35	25	—	228	—	2.1
—	—	—	—	—	—	41	41	—	276	—	2.8
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	24	17	—	198	—	2.3
—	—	—	—	—	—	37	26	—	236	—	2.3
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	24	16	—	192	—	2.4
—	—	—	—	—	—	37	26	—	230	—	2.3
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	24	16	—	192	—	2.3
—	—	—	—	—	—	37	25	—	220	—	2.3
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	15	7.1	—	158	—	1.1
—	—	—	—	—	—	24	16	—	196	—	2.6
—	—	—	—	—	—	18	7.4	—	160	—	1.7
—	—	—	—	—	—	39	26	—	234	—	2.4
—	—	—	—	—	—	53	56	—	324	—	3.6
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	24	15	—	194	—	2.5
—	—	—	—	—	—	38	26	—	240	—	2.3
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	24	15	—	194	—	2.6
—	—	—	—	—	—	39	26	—	238	—	2.4
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	23	15	—	190	—	2.6
—	—	—	—	—	—	38	26	—	238	—	2.4
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	21	14	—	178	—	1.3
—	—	—	—	—	—	23	15	—	194	—	2.7

Table 9. Physical properties and major-ion concentrations in water samples collected during cycles 1 and 2 of the injection, storage, and

Sample collection site (local well name)	Sampling date	Day of cycle phase	Collected by/ analyzed by	Specific conductance ($\mu\text{S}/\text{cm}$)	pH (standard units)	Tempera-ture, water ($^{\circ}\text{C}$)	Apparent color, unfiltered (units)	Odor threshold at 60°C (TON)	Turbidity (NTU)	Dissolved oxygen (mg/L)
Cycle 2 recovery—Continued										
4-34	12-10-97	211	LAC/LAC	383	7.7	20.0	—	—	0.1	—
4-42	12-10-97	211	LAC/LAC	429	7.9	24.5	—	—	.2	—
4-32	12-11-97	212	AVEK/AVEK	320 (L)	8.1 (L)	—	—	—	—	—
4-34	12-11-97	212	AVEK/AVEK	400 (L)	8.0 (L)	—	—	—	—	—
4-32	12-18-97	219	LAC/LAC	312	7.8	20.0	—	—	.1	—
4-34	12-18-97	219	LAC/LAC	385	7.7	20.0	—	—	<.1	—
4-32	12-18-97	219	AVEK/AVEK	320 (L)	8.2 (L)	—	—	—	—	—
4-34	12-18-97	219	AVEK/AVEK	400 (L)	8.1 (L)	—	—	—	—	—
4-32	12-24-97	225	LAC/LAC	314	7.7	20.0	—	—	<.1	—
4-34	12-24-97	225	LAC/LAC	382	7.7	20.0	—	—	<.1	—
4-32	12-24-97	225	AVEK/AVEK	320 (L)	8.2 (L)	—	—	—	—	—
4-34	12-24-97	225	AVEK/AVEK	400 (L)	8.1 (L)	—	—	—	—	—
4-32	12-31-97	232	LAC/LAC	315	7.7	21.0	—	—	<.1	—
4-34	12-31-97	232	LAC/LAC	386	7.6	21.0	—	—	<.1	—
4-32	12-31-97	232	AVEK/AVEK	320 (L)	8.2 (L)	—	—	—	—	—
4-34	12-31-97	232	AVEK/AVEK	400 (L)	8.1 (L)	—	—	—	—	—
4-32	01-05-98	237	LAC/LAC	317	7.6	20.0	—	—	.1	—
4-34	01-05-98	237	LAC/LAC	390	7.6	20.0	—	—	.1	—
4-13	01-12-98	244	LAC/LAC	299	7.8	23.0	—	—	.1	—
4-32	01-12-98	244	LAC/LAC	318	7.5	20.5	—	—	<.1	—
4-34	01-12-98	244	LAC/LAC	393	7.6	20.0	—	—	<.1	—
4-42	01-12-98	244	LAC/LAC	436	7.9	24.0	—	—	.1	—

recovery study at Lancaster, Antelope Valley, California, March 1995 through January 1998—Continued

Hardness, total (mg/L as CaCO_3)	Calcium, dissolved (mg/L)	Magnesium, dissolved (mg/L)	Sodium, dissolved (mg/L)	Potassium, dissolved (mg/L)	Alkalinity, total (mg/L as CaCO_3)	Sulfate, dissolved (mg/L)	Chloride, dissolved (mg/L)	Fluoride, dissolved (mg/L)	Dissolved solids (mg/L)	Methylene blue active substance (mg/L)	Nitrate (mg/L as NO_3)
Cycle 2 recovery—Continued											
—	—	—	—	—	—	39	26	—	242	—	2.4
—	—	—	—	—	—	41	39	—	266	—	2.6
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	23	14	—	192	—	2.7
—	—	—	—	—	—	39	26	—	242	—	2.4
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	24	14	—	194	—	2.7
—	—	—	—	—	—	40	26	—	244	—	2.4
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	24	15	—	182	—	2.7
—	—	—	—	—	—	41	27	—	250	—	2.5
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	24	14	—	172	—	2.7
—	—	—	—	—	—	41	26	—	236	—	2.5
—	—	—	—	—	—	21	15	—	182	—	1.3
—	—	—	—	—	—	23	14	.3	194	—	2.7
—	—	—	—	—	—	40	26	.2	244	—	2.5
—	—	—	—	—	—	41	39	—	266	—	2.6

Table 10. Trace-metal and metalloid concentrations in water samples collected during cycles 1 and 2 of the injection, storage, and recovery

[Sample collection sites: ground-water sites are identified by local well name (see table 1 for well information), and imported surface-water sites]

Water chemistry data were compiled from 15 active production wells from late March 1995 through mid-May 1995, prior to the beginning of the study. Department of Agricultural Commissioner and Weights and Measures; USGS, U.S. Geological Survey. $\mu\text{g/L}$, microgram per liter. <, less than value shown;

Sample collection site (local well name)	Sampling date	Day of cycle phase	Collected by/ analyzed by	Aluminum dissolved ($\mu\text{g/L}$)	Antimony dissolved ($\mu\text{g/L}$)	Arsenic, dissolved ($\mu\text{g/L}$)	Barium, dissolved ($\mu\text{g/L}$)	Beryllium, dissolved ($\mu\text{g/L}$)	Cadmium, dissolved ($\mu\text{g/L}$)
Cycle 1 pre-injection									
4-9	03-24-95	na	LAC/LAC	< 50	< 6	36	< 100	< 1	< 1
4-17	03-24-95	na	LAC/LAC	< 50	< 6	43	< 100	< 1	< 1
4-26	03-24-95	na	LAC/LAC	< 50	< 6	7	< 100	< 1	< 1
4-33	03-27-95	na	LAC/LAC	< 50	< 6	6	< 100	< 1	< 1
4-42	03-27-95	na	LAC/LAC	< 50	< 6	51	< 100	< 1	< 1
4-5	03-27-95	na	LAC/LAC	< 50	< 6	5	< 100	< 1	< 1
4-12	04-11-95	na	LAC/LAC	< 50	< 6	6	< 100	< 1	< 1
4-25	04-11-95	na	LAC/LAC	< 50	< 6	4	< 100	< 1	< 1
4-30	04-11-95	na	LAC/LAC	< 50	< 6	5	< 100	< 1	< 1
4-32	04-11-95	na	LAC/LAC	< 50	< 6	9	< 100	< 1	< 1
4-34	04-11-95	na	LAC/LAC	< 50	< 6	11	< 100	< 1	< 1
4-37	04-11-95	na	LAC/LAC	< 50	< 6	11	< 100	< 1	< 1
4-38	04-11-95	na	LAC/LAC	< 50	< 6	4	< 100	< 1	< 1
4-43	05-09-95	na	LAC/LAC	< 50	< 6	13	< 100	< 1	< 1
4-44	05-09-95	na	LAC/LAC	< 50	< 6	16	< 100	< 1	< 1
4-13	10-16-95	na	LAC/LAC	60	< 6	16	< 100	< 1	< 1
4-29	10-16-95	na	LAC/LAC	60	< 6	7	< 100	< 1	< 1
Cycle 1 storage									
4-13	05-15-96	10	LAC/LAC	< 50	< 6	26	< 100	< 1	< 1
4-29	05-15-96	10	LAC/LAC	< 50	< 6	7	< 100	< 1	< 1
4-30	05-15-96	10	LAC/LAC	< 50	< 6	< 2	< 100	< 1	< 1
4-32	05-15-96	10	LAC/LAC	< 50	< 6	< 2	< 100	< 1	< 1
4-33	05-15-96	10	LAC/LAC	< 50	< 6	4	< 100	< 1	< 1
4-34	05-15-96	10	LAC/LAC	< 50	< 6	4	< 100	< 1	< 1
4-42	05-15-96	10	LAC/LAC	< 50	< 6	47	< 100	< 1	< 1
4-43	05-15-96	10	LAC/LAC	< 50	< 6	14	< 100	< 1	< 1
4-44	05-15-96	10	LAC/LAC	< 50	< 6	18	< 100	< 1	< 1
Cycle 1 recovery									
4-5	07-26-96	67	LAC/LAC	< 50	< 6	< 2	130	< 1	< 1
4-9	07-26-96	67	LAC/LAC	< 50	< 6	< 2	< 100	< 1	< 1
4-12	07-26-96	67	LAC/LAC	< 50	< 6	< 2	< 100	< 1	< 1
4-17	07-26-96	67	LAC/LAC	< 50	< 6	93	< 100	< 1	< 1
4-25	07-26-96	67	LAC/LAC	< 50	< 6	< 2	< 100	< 1	< 1
4-26	07-26-96	67	LAC/LAC	< 50	< 6	65	< 100	< 1	< 1
4-37	07-26-96	67	LAC/LAC	< 50	< 6	9	< 100	< 1	< 1
4-38	07-26-96	67	LAC/LAC	< 50	< 6	< 2	140	< 1	< 1
Cycle 2 pre-injection									
5K8-PZ1	10-31-96	11	USGS/LAC	< 50	< 6	35	< 100	< 1	< 1
5K8-PZ2	10-31-96	11	USGS/LAC	300	< 6	6	< 100	< 1	< 1
5K8-PZ3	10-31-96	11	USGS/LAC	< 50	< 6	3	< 100	< 1	< 1
5K8-PZ4	10-31-96	11	USGS/LAC	< 50	< 6	< 2	< 100	< 1	< 1
4-5	10-31-96	11	LAC/LAC	< 50	< 6	< 2	< 100	< 1	< 1

study at Lancaster, Antelope Valley, California, March 1995 through June 1997

(the injection wells) are identified by the local well name and the name of the water-importing agency (AVEK, Antelope Valley–East Kern Water Agency). Water in AVEK wells 4-32 and 4-34 was sampled as the water was injected during cycles 1 and 2. Collected by/ analyzed by: LAC, Los Angeles County na, not applicable]

Chromium, total ($\mu\text{g/L}$)	Copper, dissolved ($\mu\text{g/L}$)	Iron, dissolved ($\mu\text{g/L}$)	Lead, dissolved ($\mu\text{g/L}$)	Manganese, dissolved ($\mu\text{g/L}$)	Mercury, dissolved ($\mu\text{g/L}$)	Nickel, dissolved ($\mu\text{g/L}$)	Selenium, dissolved ($\mu\text{g/L}$)	Silver, dissolved ($\mu\text{g/L}$)	Thallium, dissolved ($\mu\text{g/L}$)	Zinc, dissolved ($\mu\text{g/L}$)
Cycle 1 pre-injection										
10	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
10	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
10	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
< 10	< 50	< 100	< 5	< 30	< 1.0	< 10	5	< 10	< 1	< 50
< 10	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
10	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
10	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
10	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
10	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
< 10	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
10	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
10	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
< 10	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
11	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
10	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
< 10	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
< 10	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
< 10	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
< 10	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
< 10	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
< 10	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
Cycle 1 storage										
< 10	< 50	100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
20	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
10	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
< 10	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	260
10	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
< 10	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	160
< 10	< 50	130	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
< 10	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
< 10	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
Cycle 1 recovery										
< 10	< 50	< 100	< 5	30	< 1.0	< 10	< 5	< 10	< 1	< 50
10	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
< 10	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
< 10	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
< 10	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
< 10	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
< 10	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
Cycle 2 pre-injection										
< 10	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
< 10	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
< 10	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
10	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
10	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50

Table 10. Trace-metal and metalloid concentrations in water samples collected during cycles 1 and 2 of the injection, storage, and recovery

Sample collection site (local well name)	Sampling date	Day of cycle phase	Collected by/ analyzed by	Aluminum dissolved (µg/L)	Antimony dissolved (µg/L)	Arsenic, dissolved (µg/L)	Barium, dissolved (µg/L)	Beryllium, dissolved (µg/L)	Cadmium, dissolved (µg/L)
Cycle 2 pre-injection—Continued									
4-9	10-31-96	11	LAC/LAC	< 50	< 6	51	< 100	< 1	< 1
4-25	10-31-96	11	LAC/LAC	< 50	< 6	2	< 100	< 1	< 1
4-26	10-31-96	11	LAC/LAC	< 50	< 6	31	< 100	< 1	< 1
4-29	10-31-96	11	LAC/LAC	< 50	< 6	13	< 100	< 1	< 1
4-37	10-31-96	11	LAC/LAC	< 50	< 6	< 2	< 100	< 1	< 1
4-38	10-31-96	11	LAC/LAC	< 50	< 6	< 2	< 100	< 1	< 1
4-44	10-31-96	11	LAC/LAC	< 50	< 6	17	< 100	< 1	< 1
4-12	11-01-96	12	LAC/LAC	< 50	< 6	2	< 100	< 1	< 1
4-13	11-01-96	12	LAC/LAC	< 50	< 6	13	< 100	< 1	< 1
4-17	11-01-96	12	LAC/LAC	< 50	< 6	34	< 100	< 1	< 1
4-30	11-01-96	12	LAC/LAC	< 50	< 6	< 2	< 100	< 1	< 1
4-32	11-01-96	12	LAC/LAC	50	< 6	< 2	< 100	< 1	< 1
4-33	11-01-96	12	LAC/LAC	< 50	< 6	< 2	< 100	< 1	< 1
4-34	11-01-96	12	LAC/LAC	50	< 6	5	< 100	< 1	< 1
4-42	11-01-96	12	LAC/LAC	< 50	< 6	36	< 100	< 1	< 1
4-43	11-01-96	12	LAC/LAC	< 50	< 6	11	< 100	< 1	< 1
DK8-PZ1	11-07-96	18	USGS/LAC	< 50	< 6	60	< 100	< 1	< 1
Cycle 2 injection									
4-32(AVEK)	11-12-96	1	LAC/LAC	< 50	< 6	< 2	< 100	< 1	< 1
4-34(AVEK)	11-12-96	1	LAC/LAC	< 50	< 6	< 2	< 100	< 1	< 1
4-32(AVEK)	01-09-97	59	LAC/LAC	70	< 6	< 2	< 100	< 1	< 1
4-34(AVEK)	01-09-97	59	LAC/LAC	60	< 6	< 2	< 100	< 1	< 1
4-5	02-05-97	86	LAC/LAC	< 50	< 6	5	< 100	< 1	< 1
4-9	02-05-97	86	LAC/LAC	< 50	< 6	36	< 100	< 1	< 1
4-12	02-05-97	86	LAC/LAC	< 50	< 6	6	< 100	< 1	< 1
4-13	02-05-97	86	LAC/LAC	< 50	< 6	24	< 100	< 1	< 1
4-17	02-05-97	86	LAC/LAC	< 50	< 6	34	< 100	< 1	< 1
4-25	02-05-97	86	LAC/LAC	< 50	< 6	4	< 100	< 1	< 1
4-26	02-05-97	86	LAC/LAC	< 50	< 6	33	< 100	< 1	< 1
4-29	02-05-97	86	LAC/LAC	60	< 6	7	< 100	< 1	< 1
4-30	02-05-97	86	LAC/LAC	< 50	< 6	2	< 100	< 1	< 1
4-33	02-05-97	86	LAC/LAC	< 50	< 6	3	< 100	< 1	< 1
4-37	02-05-97	86	LAC/LAC	< 50	< 6	11	< 100	< 1	< 1
4-38	02-05-97	86	LAC/LAC	< 50	< 6	< 2	< 100	< 1	< 1
4-42	02-05-97	86	LAC/LAC	< 50	< 6	42	< 100	< 1	< 1
4-43	02-05-97	86	LAC/LAC	< 50	< 6	14	150	< 1	< 1
4-44	02-06-97	87	LAC/LAC	< 50	< 6	16	150	< 1	< 1
4-32(AVEK)	02-13-97	94	LAC/LAC	< 50	< 6	< 2	< 100	< 1	< 1
4-34(AVEK)	02-13-97	94	LAC/LAC	< 50	< 6	< 2	< 100	< 1	< 1

study at Lancaster, Antelope Valley, California, March 1995 through June 1997—Continued

Table 10. Trace-metal and metalloid concentrations in water samples collected during cycles 1 and 2 of the injection, storage, and recovery

Sample collection site (local well name)	Sampling date	Day of cycle phase	Collected by/ analyzed by	Aluminum dissolved (µg/L)	Antimony dissolved (µg/L)	Arsenic, dissolved (µg/L)	Barium, dissolved (µg/L)	Beryllium, dissolved (µg/L)	Cadmium, dissolved (µg/L)
Cycle 2 storage									
5K8-PZ1	05-06-97	20	USGS/LAC	< 50	< 6	64	< 100	< 1	< 1
5K8-PZ2	05-06-97	20	USGS/LAC	< 50	< 6	8	< 100	< 1	< 1
5K8-PZ3	05-06-97	20	USGS/LAC	< 50	< 6	2	170	< 1	< 1
5K8-PZ4	05-06-97	20	USGS/LAC	< 50	< 6	6	< 100	< 1	< 1
4-5	05-06-97	20	LAC/LAC	< 50	< 6	13	< 100	< 1	< 1
4-9	05-06-97	20	LAC/LAC	< 50	< 6	49	< 100	< 1	< 1
4-12	05-06-97	20	LAC/LAC	< 50	< 6	11	< 100	< 1	< 1
4-25	05-06-97	20	LAC/LAC	< 50	< 6	< 2	< 100	< 1	< 1
4-26	05-06-97	20	LAC/LAC	< 50	< 6	40	< 100	< 1	< 1
4-37	05-06-97	20	LAC/LAC	< 50	< 6	22	< 100	< 1	< 1
4-38	05-06-97	20	LAC/LAC	< 50	< 6	< 2	< 100	< 1	< 1
4-29	05-07-97	21	LAC/LAC	< 50	< 6	6	< 100	< 1	< 1
4-30	05-07-97	21	LAC/LAC	< 50	< 6	8	< 100	< 1	< 1
4-34	05-07-97	21	LAC/LAC	50	< 6	< 2	< 100	< 1	< 1
4-43	05-07-97	21	LAC/LAC	< 50	< 6	14	140	< 1	< 1
DK8-PZ1	05-08-97	22	USGS/LAC	< 50	< 6	68	< 100	< 1	< 1
4-17	05-08-97	22	LAC/LAC	< 50	< 6	45	< 100	< 1	< 1
4-44	05-08-97	22	LAC/LAC	< 50	< 6	17	120	< 1	< 1
4-13	05-09-97	23	LAC/LAC	< 50	< 6	29	< 100	< 1	< 1
4-33	05-09-97	23	LAC/LAC	< 50	< 6	< 2	< 100	< 1	< 1
4-42	05-09-97	23	LAC/LAC	< 50	< 6	47	< 100	< 1	< 1
Cycle 2 recovery									
4-32	05-14-97	1	LAC/LAC	100	< 6	5	< 100	< 1	< 1
4-13	06-12-97	30	LAC/LAC	< 50	< 6	16	< 100	< 1	< 1
4-33	06-12-97	30	LAC/LAC	< 50	< 6	8	< 100	< 1	< 1
4-42	06-12-97	30	LAC/LAC	< 50	< 6	32	< 100	< 1	< 1
4-32	06-13-97	31	LAC/LAC	< 50	< 6	7	< 100	< 1	< 1

study at Lancaster, Antelope Valley, California, March 1995 through June 1997—Continued

Chromium, total ($\mu\text{g/L}$)	Copper, dissolved ($\mu\text{g/L}$)	Iron, dissolved ($\mu\text{g/L}$)	Lead, dissolved ($\mu\text{g/L}$)	Manganese, dissolved ($\mu\text{g/L}$)	Mercury, dissolved ($\mu\text{g/L}$)	Nickel, dissolved ($\mu\text{g/L}$)	Selenium, dissolved ($\mu\text{g/L}$)	Silver, dissolved ($\mu\text{g/L}$)	Thallium, dissolved ($\mu\text{g/L}$)	Zinc, dissolved ($\mu\text{g/L}$)
Cycle 2 storage										
< 10	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
< 10	< 50	< 100	< 5	< 30	< 1.0	< 10	6	< 10	< 1	< 50
< 10	< 50	< 100	< 5	< 30	< 1.0	< 10	6	< 10	< 1	< 50
10	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
20	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
20	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
10	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
20	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
10	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
14	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
20	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
< 10	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
< 10	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
< 10	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
< 10	< 50	770	< 5	30	< 1.0	< 10	< 5	< 10	< 1	260
< 10	< 50	< 100	< 5	< 30	< 1.0	< 10	7	< 10	< 1	< 50
< 10	< 50	< 100	< 5	< 30	< 1.0	< 10	8	< 10	< 1	< 50
10	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
< 10	< 50	< 100	< 5	< 30	< 1.0	< 10	6	< 10	< 1	< 50
< 10	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
< 10	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
< 10	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
Cycle 2 recovery										
20	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	130
10	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
11	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
< 10	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	< 50
< 10	< 50	< 100	< 5	< 30	< 1.0	< 10	< 5	< 10	< 1	120

Table 11. Trihalomethane concentrations, trihalomethane formation potentials, and associated parameters for water samples collected during cycles 1 and 2 of the injection, storage, and recovery study at Lancaster, Antelope Valley, California, April 1995 through January 1998

[Sample collection sites: ground-water sites are identified by local well name (see table 1 for well information), and imported surface-water sites are identified by local well name and the name of the water-importing agency (AVEK, Antelope Valley-East Kern Water Agency). Water-chemistry data was compiled from well 4-32 in April 1995 prior to the beginning of the study. Water in AVEK wells 4-32 and 4-34 was sampled as the water was injected during cycles 1 and 2. FP, formation potential; LAC, Los Angeles County Department of Agricultural Commissioner and Weights and Measures; USGS, U.S. Geological Survey. CHCl₃, chloroform; CHCl₂Br, bromodichloromethane; CHBr₂Cl, chlorodibromomethane; CHBr₃, bromoform; TTHM, total trihalomethanes. Ultraviolet absorbance at 254 nanometers. µg/L, microgram per liter; mg/L, milligram per liter; cm, centimeter. <, less than value shown; ND, not detected; na, not applicable; —, no data.]

Sample collection site (local well name)	Sampling date	Day of cycle phase	Collected by/analyzed by	CHCl ₃ (µg/L)	CHCl ₃ FP (µg/L)	CHCl ₂ Br (µg/L)	CHCl ₂ Br FP (µg/L)	CHBr ₂ Cl (µg/L)	CHBr ₂ Cl FP (µg/L)	CHBr ₃ (µg/L)	CHBr ₃ FP (µg/L)	TTHM (µg/L)	TTHM FP (µg/L)	Total organic carbon (mg/L)	Free residual chlorine (mg/L)	Total residual chlorine (mg/L)	Ultra-violet absorbance (per cm)
Cycle 1 pre-injection																	
4-32	04-11-95	na	LAC/LAC	—	—	—	—	—	—	—	—	<0.5	—	—	—	—	
4-13	10-16-95	na	LAC/LAC	—	—	—	—	—	—	—	—	<.5	—	—	—	—	
4-29	10-16-95	na	LAC/LAC	—	—	—	—	—	—	—	—	<.5	—	—	—	—	
Cycle 1 injection																	
4-32(AVEK)	04-09-96	2	AVEK/AVEK	16	—	17	—	11	—	2.2	—	47	—	—	0.70	0.90	0.027
4-32(AVEK)	04-11-96	4	LAC/LAC	16	25	15	18	8.1	10	<.5	<0.5	39	52	7.1	—	—	—
4-32(AVEK)	04-11-96	4	AVEK/AVEK	15	—	14	—	9.1	—	2.1	—	41	—	1.8	.70	.80	.024
4-32(AVEK)	04-18-96	11	AVEK/AVEK	9.8	—	12	—	12	—	2.8	—	37	—	1.6	.70	.90	.018
4-32(AVEK)	04-19-96	12	LAC/LAC	10	17	14	16	9.4	11	<.5	<.5	34	44	3.0	—	—	—
4-32(AVEK)	04-25-96	18	AVEK/AVEK	8.9	—	14	—	16	—	3.2	—	42	—	1.9	.75	.90	.029
4-32(AVEK)	04-26-96	19	LAC/LAC	8.0	19	13	22	14	19	1.6	1.8	37	62	13	—	—	—
4-32(AVEK)	05-02-96	25	LAC/LAC	9.7	13	19	23	27	28	<.5	<.5	56	64	4.9	—	—	—
4-32(AVEK)	05-02-96	25	AVEK/AVEK	9.4	—	18	—	25	—	5.9	—	59	—	2.4	—	.45	.039
Cycle 1 storage																	
4-13	05-16-96	11	LAC/LAC	—	20	—	9.3	—	2.1	—	<0.5	<0.5	31	1.6	—	—	—
4-32	05-16-96	11	LAC/LAC	32	77	34	54	30	40	<0.5	3.4	96	175	5.6	—	—	—
4-33	05-16-96	11	LAC/LAC	—	7.3	—	1.5	—	<.5	—	<.5	<.5	8.8	1.3	—	—	—
4-34	05-16-96	11	LAC/LAC	31	80	38	61	46	53	4.7	12	119	205	6.1	—	—	—
4-42	05-16-96	11	LAC/LAC	—	26	—	16	—	4.0	—	<.5	<.5	46	1.7	—	—	—
4-13	05-17-96	12	LAC/LAC	—	11	—	11	—	2.1	—	<.5	<.5	24	3.2	—	—	—
4-32	05-17-96	12	LAC/LAC	24	87	27	83	28	44	<.5	<.5	79	214	4.3	—	—	—
4-32	05-17-96	12	AVEK/AVEK	25	—	27	—	28	—	6.5	<.5	87	—	2.0	ND	ND	0.290
4-33	05-17-96	12	LAC/LAC	—	9.1	—	2.9	—	<.5	—	<.5	<.5	12	2.1	—	—	—
4-34	05-17-96	12	LAC/LAC	20	76	29	73	35	44	<.5	<.5	85	192	5.1	—	—	—
4-42	05-17-96	12	LAC/LAC	—	12	—	9.4	—	2.1	—	<.5	<.5	24	2.3	—	—	—
Cycle 1 recovery																	
4-32	05-21-96	1	AVEK/AVEK	21	—	—	—	25	—	4.8	—	76	—	1.7	ND	ND	0.230
4-34	05-21-96	1	AVEK/AVEK	33	—	26	—	30	—	6.0	—	95	—	1.7	ND	ND	.033
4-13	05-22-96	2	LAC/LAC	—	8.4	—	7.9	—	<0.5	—	<0.5	<.5	16	1.3	—	—	—
4-32	05-22-96	2	LAC/LAC	17	56	40	58	53	41	<.5	<.5	109	156	3.2	—	—	—
4-33	05-22-96	2	LAC/LAC	—	14	—	2.7	—	<.5	—	<.5	<.5	17	<1.0	—	—	—

Table 11. Trihalomethane concentrations, trihalomethane formation potentials, and associated parameters for water samples collected during cycles 1 and 2 of the injection, storage, and recovery study at Lancaster, Antelope Valley, California, April 1995 through January 1998—Continued

Sample collection site (local well name)	Sampling date	Day of cycle phase	Collected by/ analyzed by	CHCl ₃ (µg/L)	CHCl ₃ FP (µg/L)	CHCl ₂ Br (µg/L)	CHCl ₂ Br FP (µg/L)	CHBr ₂ Cl (µg/L)	CHBr ₂ Cl FP (µg/L)	CHBr ₃ (µg/L)	CHBr ₃ FP (µg/L)	TTHM (µg/L)	TTHM FP (µg/L)	Total organic carbon (mg/L)	Free residual chlorine (mg/L)	Total residual chlorine (mg/L)	Ultra-violet absorbance (per cm)
Cycle 1 recovery—Continued																	
4-34	05-22-96	2	LAC/LAC	16	51	37	54	50	41	< 0.5	< 0.5	103	145	< 1.0	—	—	—
4-42	05-22-96	2	LAC/LAC	—	9.9	—	8.0	—	1.4	< .5	< .5	19	< 1.0	—	—	—	—
4-32	05-23-96	3	AVEK/AVEK	21	—	27	—	32	—	6.3	—	86	—	1.4	ND	ND	0.270
4-34	05-23-96	3	AVEK/AVEK	18	—	24	—	26	—	5.0	—	73	—	1.6	ND	ND	.160
4-13	05-24-96	4	LAC/LAC	—	8.2	—	4.2	—	< .5	—	< .5	< .5	13	< 1.0	—	—	—
4-32	05-24-96	4	LAC/LAC	12	57	30	47	36	31	< .5	< .5	78	135	2.7	—	—	—
4-33	05-24-96	4	LAC/LAC	—	6.6	—	1.4	—	< .5	—	< .5	< .5	8.0	< 1.0	—	—	—
4-34	05-24-96	4	LAC/LAC	12	56	29	51	36	30	< .5	< .5	78	137	1.1	—	—	—
4-42	05-24-96	4	LAC/LAC	—	16	—	19	—	< .5	—	< .5	< .5	35	< 1.0	—	—	—
4-13	05-28-96	8	LAC/LAC	—	4.2	—	2.2	—	< .5	—	< .5	< .5	6.4	< 1.0	—	—	—
4-32	05-28-96	8	LAC/LAC	12	28	25	20	24	9.4	< .5	< .5	62	58	< 1.0	—	—	—
4-33	05-28-96	8	LAC/LAC	—	7.3	—	2.2	—	< .5	—	< .5	< .5	9.5	5.9	—	—	—
4-34	05-28-96	8	LAC/LAC	13	44	24	36	24	18	< .5	< .5	61	97	< 1.0	—	—	—
4-42	05-28-96	8	LAC/LAC	—	6.3	—	3.5	—	< .5	—	< .5	< .5	9.8	< 1.0	—	—	—
4-13	05-30-96	10	LAC/LAC	—	4.2	—	< .5	—	< .5	—	< .5	< .5	4.2	< 1.0	—	—	—
4-32	05-30-96	10	LAC/LAC	12	24	23	21	20	14	< .5	< .5	55	59	< 1.0	—	—	—
4-32	05-30-96	10	AVEK/AVEK	15	—	15	—	13	—	3.2	—	47	—	.9	ND	ND	.160
4-33	05-30-96	10	LAC/LAC	—	8.1	—	1.6	—	< .5	—	< .5	< .5	9.7	< 1.0	—	—	—
4-34	05-30-96	10	LAC/LAC	11	28	23	21	20	5.8	< .5	< .5	54	54	< 1.0	—	—	—
4-34	05-30-96	10	AVEK/AVEK	14	—	14	—	13	—	3.2	—	44	—	1.1	ND	ND	.130
4-42	05-30-96	10	LAC/LAC	—	15	—	9.3	—	< .5	—	< .5	< .5	24	< 1.0	—	—	—
4-13	05-31-96	11	LAC/LAC	—	2.4	—	.9	—	.6	—	< .5	< .5	3.9	2.3	—	—	—
4-32	05-31-96	11	LAC/LAC	17	22	20	12	13	9.1	< .5	1.2	50	44	2.8	—	—	—
4-33	05-31-96	11	LAC/LAC	—	2.5	—	.8	—	1.0	—	< .5	< .5	4.3	2.3	—	—	—
4-34	05-31-96	11	LAC/LAC	14	20	19	10	11	9.1	< .5	1.3	44	40	< 1.0	—	—	—
4-42	05-31-96	11	LAC/LAC	—	4.3	—	3.7	—	1.9	—	< .5	< .5	9.9	2.4	—	—	—
4-13	06-03-96	14	LAC/LAC	—	2.4	—	2.4	—	.8	—	< .5	< .5	5.6	2.0	—	—	—
4-32	06-03-96	14	LAC/LAC	12	21	14	24	7.0	10	< .5	< .5	33	55	2.5	—	—	—
4-33	06-03-96	14	LAC/LAC	—	2.2	—	2.8	—	< .5	—	< .5	< .5	5.0	1.2	—	—	—
4-34	06-03-96	14	LAC/LAC	12	8.1	15	11	6.9	1.7	< .5	< .5	33	21	1.2	—	—	—

Table 11

Table 11. Trihalomethane concentrations, trihalomethane formation potentials, and associated parameters for water samples collected during cycles 1 and 2 of the injection, storage, and recovery study at Lancaster, Antelope Valley, California, April 1995 through January 1998—Continued

Sample collection site (local well name)	Sampling date	Day of cycle phase	Collected by/ analyzed by	CHCl ₃ (μg/L)	CHCl ₃ FP (μg/L)	CHCl ₂ Br (μg/L)	CHCl ₂ Br FP (μg/L)	CHBr ₂ Cl (μg/L)	CHBr ₂ Cl FP (μg/L)	CHBr ₃ (μg/L)	CHBr ₃ FP (μg/L)	TTHM (μg/L)	TTHM FP (μg/L)	Total organic carbon (mg/L)	Free residual chlorine (mg/L)	Total residual chlorine (mg/L)	Ultra-violet absorbance (per cm)
Cycle 1 recovery—Continued																	
4-42	06-03-96	14	LAC/LAC	—	2.3	—	4.0	—	1.3	—	<0.5	<0.5	13	1.1	—	—	
4-13	06-04-96	15	LAC/LAC	—	2.5	—	3.1	—	<.5	—	<.5	<.5	5.5	1.4	—	—	
4-32	06-04-96	15	LAC/LAC	8.4	24	3.5	17	2.2	9.1	1.2	<.5	15	50	10	—	—	
4-33	06-04-96	15	LAC/LAC	—	2.4	—	2.4	—	<.5	—	<.5	<.5	4.8	2.2	—	—	
4-34	06-04-96	15	LAC/LAC	8.7	22	3.6	20	2.0	14	<.5	<.5	15	56	3.2	—	—	
4-42	06-04-96	15	LAC/LAC	—	3.9	—	4.1	—	<.5	—	<.5	<.5	8.0	310	—	—	
4-13	06-06-96	17	LAC/LAC	—	7.2	—	5.1	—	<.5	—	<.5	<.5	12	31	—	—	
4-32	06-06-96	17	LAC/LAC	7.8	23	3.5	9.8	1.6	5.7	<.5	<.5	13	39	6.6	—	—	
4-33	06-06-96	17	LAC/LAC	—	4.2	—	1.8	—	<.5	—	<.5	<.5	6.0	6.4	—	—	
4-34	06-06-96	17	LAC/LAC	7.8	20	3.7	19	1.6	12	<.5	<.5	13	50	8.1	—	—	
4-42	06-06-96	17	LAC/LAC	—	4.8	—	13	—	4.4	—	<.5	<.5	22	8.5	—	—	
4-13	06-07-96	18	LAC/LAC	—	2.5	—	1.9	—	<.5	—	<.5	<.5	4.4	7.2	—	—	
4-32	06-07-96	18	LAC/LAC	6.5	3.2	.9	.6	1.5	1.2	.7	<.5	9.6	5.0	1.2	—	—	
4-32	06-07-96	18	AVEK/AVEK	8.2	—	7.5	—	6.3	—	2.3	—	24	—	.6	ND	ND	0.005
4-33	06-07-96	18	LAC/LAC	—	146	—	7.2	—	<.5	—	<.5	<.5	153	7.4	—	—	
4-34	06-07-96	18	LAC/LAC	7.2	1.6	1.0	.8	1.7	<.5	.9	<.5	11	2.4	4.2	—	—	
4-34	06-07-96	18	AVEK/AVEK	7.7	—	7.8	—	6.1	—	2.2	—	24	—	—	ND	ND	.100
4-42	06-07-96	18	LAC/LAC	—	17	—	15	—	6.9	—	<.5	<.5	39	8.9	—	—	
4-13	06-08-96	19	LAC/LAC	—	2.0	—	2.3	—	<.5	—	<.5	<.5	4.3	4.5	—	—	
4-32	06-08-96	19	LAC/LAC	7.5	14	7.2	12	<.5	4.2	<.5	<.5	15	25	<1.0	—	—	
4-33	06-08-96	19	LAC/LAC	—	1.2	—	.8	—	<.5	—	<.5	<.5	2.0	5.1	—	—	
4-34	06-08-96	19	LAC/LAC	8.7	11	8.0	18	5.7	6.6	<.5	<.5	22	35	4.9	—	—	
4-42	06-08-96	19	LAC/LAC	—	2.7	—	4.6	—	1.2	—	<.5	<.5	8.5	3.4	—	—	
4-13	06-09-96	20	LAC/LAC	—	2.2	—	1.4	—	<.5	—	<.5	<.5	3.6	1.3	—	—	
4-32	06-09-96	20	LAC/LAC	5.7	14	2.1	17	3.4	4.5	<.5	<.5	11	35	14	—	—	
4-33	06-09-96	20	LAC/LAC	—	1.6	—	<.5	—	<.5	—	<.5	<.5	1.6	3.9	—	—	
4-34	06-09-96	20	LAC/LAC	5.6	16	2.1	16	3.5	<.5	<.5	<.5	11	32	2.8	—	—	
4-42	06-09-96	20	LAC/LAC	—	2.5	—	2.4	—	<.5	—	<.5	<.5	4.9	5.7	—	—	
4-13	06-10-96	21	LAC/LAC	—	2.0	—	1.2	—	<.5	—	<.5	<.5	3.2	22	—	—	
4-32	06-10-96	21	LAC/LAC	3.0	14	4.1	19	<.5	5.3	<.5	<.5	7.1	28	22	—	—	

Table 11. Trihalomethane concentrations, trihalomethane formation potentials, and associated parameters for water samples collected during cycles 1 and 2 of the injection, storage, and recovery study at Lancaster, Antelope Valley, California, April 1995 through January 1998—Continued

Sample collection site (local well name)	Sampling date	Day of cycle phase	Collected by/ analyzed by	CHCl ₃ (µg/L)	CHCl ₃ FP (µg/L)	CHCl ₂ Br (µg/L)	CHCl ₂ Br FP (µg/L)	CHBr ₂ Cl (µg/L)	CHBr ₂ Cl FP (µg/L)	CHBr ₃ (µg/L)	CHBr ₃ FP (µg/L)	TTHM (µg/L)	TTHM FP (µg/L)	Total organic carbon (mg/L)	Free residual chlorine (mg/L)	Total residual chlorine (mg/L)	Ultra-violet absorbance (per cm)
Cycle 1 recovery—Continued																	
4-33	06-10-96	21	LAC/LAC	—	1.0	—	< 0.5	—	< 0.5	—	< 0.5	< 0.5	1.0	25	—	—	
4-34	06-10-96	21	LAC/LAC	3.7	11	5.1	9.9	4.4	7.8	< 0.5	< .5	13	29	6.7	—	—	
4-42	06-10-96	21	LAC/LAC	—	1.0	—	< .5	—	< .5	—	< .5	< .5	1.0	26	—	—	
4-13	06-11-96	22	LAC/LAC	—	2.8	—	1.4	—	< .5	—	< .5	< .5	4.2	4.5	—	—	
4-32	06-11-96	22	LAC/LAC	4.5	14	5.6	9.7	3.3	4.3	.6	< .5	14	28	12	—	—	
4-33	06-11-96	22	LAC/LAC	—	.6	—	< .5	—	< .5	—	< .5	< .5	.6	6.4	—	—	
4-34	06-11-96	22	LAC/LAC	4.8	2.9	4.4	4.0	3.4	< .5	.5	< .5	13	6.9	12	—	—	
4-42	06-11-96	22	LAC/LAC	—	< .5	—	< .5	—	< .5	—	< .5	< .5	< .5	3.5	—	—	
4-13	06-12-96	23	LAC/LAC	—	2.8	—	1.6	—	< .5	—	< .5	< .5	4.4	9.3	—	—	
4-32	06-12-96	23	LAC/LAC	4.7	1.4	5.1	1.0	3.0	< .5	.6	< .5	13	2.4	3.4	—	—	
4-33	06-12-96	23	LAC/LAC	—	1.6	—	< .5	—	< .5	—	< .5	< .5	1.6	4.3	—	—	
4-34	06-12-96	23	LAC/LAC	5.2	13	5.7	11	3.3	5.5	.6	< .5	15	30	12	—	—	
4-42	06-12-96	23	LAC/LAC	—	2.4	—	2.8	—	< .5	—	< .5	< .5	5.2	19	—	—	
4-13	06-13-96	24	LAC/LAC	—	2.5	—	1.9	—	.8	—	< .5	< .5	5.2	2.9	—	—	
4-32	06-13-96	24	LAC/LAC	5.5	9.1	5.4	7.2	3.9	3.7	.5	< .5	15	20	5.6	—	—	
4-32	06-13-96	24	AVEK/AVEK	4.2	—	4.2	—	3.4	—	< .5	—	12	—	< .5	ND	ND	0.000
4-33	06-13-96	24	LAC/LAC	—	3.0	—	1.6	—	< .5	—	< .5	< .5	4.6	2.1	—	—	
4-34	06-13-96	24	LAC/LAC	3.0	3.9	3.6	3.9	3.0	2.5	< .5	< .5	9.6	10	4.2	—	—	
4-34	06-13-96	24	AVEK/AVEK	4.9	—	4.4	—	3.9	—	< .5	—	13	—	—	ND	ND	.001
4-42	06-13-96	24	LAC/LAC	—	3.0	—	1.6	—	< .5	—	< .5	< .5	4.6	1.1	—	—	
4-13	06-14-96	25	LAC/LAC	—	2.7	—	1.7	—	< .5	—	< .5	< .5	4.4	< 1.0	—	—	
4-32	06-14-96	25	LAC/LAC	5.3	14	4.5	8.6	4.1	< .5	1.5	< .5	15	23	< 1.0	—	—	
4-33	06-14-96	25	LAC/LAC	—	2.0	—	< .5	—	< .5	—	< .5	< .5	2.0	< 1.0	—	—	
4-34	06-14-96	25	LAC/LAC	4.1	10	3.4	9.0	2.2	5.1	.4	< .5	10	24	< 1.0	—	—	
4-42	06-14-96	25	LAC/LAC	—	3.3	—	2.8	—	< .5	—	< .5	< .5	6.1	< 1.0	—	—	
4-13	06-15-96	26	LAC/LAC	—	2.9	—	2.5	—	1.2	—	< .5	< .5	6.6	< 1.0	—	—	
4-32	06-15-96	26	LAC/LAC	4.9	3.5	4.3	2.8	2.6	1.7	< .5	< .5	12	8.0	< 1.0	—	—	
4-33	06-15-96	26	LAC/LAC	—	1.9	—	1.3	—	.7	—	< .5	< .5	3.9	< 1.0	—	—	
4-34	06-15-96	26	LAC/LAC	4.6	8.4	4.7	17	3.3	5.9	< .5	< .5	13	32	< 1.0	—	—	
4-42	06-15-96	26	LAC/LAC	—	1.0	—	1.0	—	.6	—	< .5	< .5	2.6	< 1.0	—	—	

Table 11. Trihalomethane concentrations, trihalomethane formation potentials, and associated parameters for water samples collected during cycles 1 and 2 of the injection, storage, and recovery study at Lancaster, Antelope Valley, California, April 1995 through January 1998—Continued

Sample collection site (local well name)	Sampling date	Day of cycle phase	Collected by/ analyzed by	CHCl ₃ (μg/L)	CHCl ₃ FP (μg/L)	CHCl ₂ Br (μg/L)	CHCl ₂ Br FP (μg/L)	CHBr ₂ Cl (μg/L)	CHBr ₂ Cl FP (μg/L)	CHBr ₃ (μg/L)	CHBr ₃ FP (μg/L)	TTHM (μg/L)	TTHM FP (μg/L)	Total organic carbon (mg/L)	Free residual chlorine (mg/L)	Total residual chlorine (mg/L)	Ultra-violet absorbance (per cm)
Cycle 1 recovery—Continued																	
4-13	06-16-96	27	LAC/LAC	—	3.0	—	1.4	—	0.6	—	< 0.5	< 0.5	5.0	< 1.0	—	—	—
4-32	06-16-96	27	LAC/LAC	3.5	5.5	1.7	3.2	1.9	1.5	< 0.5	< .5	7.1	10	< 1.0	—	—	—
4-33	06-16-96	27	LAC/LAC	—	2.0	—	2.8	—	< .5	—	< .5	< .5	4.8	< 1.0	—	—	—
4-34	06-16-96	27	LAC/LAC	3.8	5.4	2.4	3.7	2.5	1.9	< .5	< .5	8.7	11	< 1.0	—	—	—
4-42	06-16-96	27	LAC/LAC	—	3.0	—	3.3	—	1.5	—	< .5	< .5	7.8	1.3	—	—	—
4-13	06-17-96	28	LAC/LAC	—	3.3	—	2.3	—	< .5	—	< .5	< .5	5.6	5.4	—	—	—
4-32	06-17-96	28	LAC/LAC	3.4	9.2	3.4	7.8	2.1	< .5	< .5	< .5	8.9	17	1.4	—	—	—
4-33	06-17-96	28	LAC/LAC	—	2.0	—	< .5	—	< .5	—	< .5	< .5	2.0	5.8	—	—	—
4-34	06-17-96	28	LAC/LAC	3.9	8.0	3.7	9.9	2.8	< .5	< .5	10	18	22	—	—	—	—
4-42	06-17-96	28	LAC/LAC	—	2.6	—	3.4	—	< .5	—	< .5	< .5	6.0	4.5	—	—	—
4-13	06-18-96	29	LAC/LAC	—	2.7	—	1.6	—	.6	—	< .5	< .5	4.9	2.1	—	—	—
4-32	06-18-96	29	LAC/LAC	3.0	7.7	2.4	2.3	1.9	1.9	< .5	< .5	7.3	12	4.0	—	—	—
4-33	06-18-96	29	LAC/LAC	—	2.6	—	1.5	—	.8	—	< .5	< .5	4.9	2.7	—	—	—
4-34	06-18-96	29	LAC/LAC	3.5	6.8	3.1	1.3	2.8	2.7	< .5	< .5	9.4	11	3.7	—	—	—
4-42	06-18-96	29	LAC/LAC	—	2.3	—	1.8	—	1.5	—	< .5	< .5	5.6	8.9	—	—	—
4-13	06-19-96	30	LAC/LAC	—	2.1	—	2.0	—	1.3	—	< .5	< .5	5.4	3.7	—	—	—
4-32	06-19-96	30	LAC/LAC	3.4	3.1	2.3	3.8	1.8	3.1	< .5	< .5	7.5	10	3.3	—	—	—
4-33	06-19-96	30	LAC/LAC	—	1.3	—	1.1	—	< .5	—	< .5	< .5	2.4	2.4	—	—	—
4-34	06-19-96	30	LAC/LAC	3.3	3.8	2.7	5.4	2.1	4.3	< .5	< .5	8.1	14	1.2	—	—	—
4-42	06-19-96	30	LAC/LAC	—	1.7	—	2.1	—	1.7	—	< .5	< .5	5.5	1.5	—	—	—
4-13	06-20-96	31	LAC/LAC	—	2.8	—	2.1	—	< .5	—	< .5	< .5	4.9	< 1.0	—	—	—
4-32	06-20-96	31	LAC/LAC	2.4	9.9	2.6	8.4	.9	< .5	< .5	< .5	5.9	18	< 1.0	—	—	—
4-32	06-20-96	31	AVEK/AVEK	2.7	—	2.5	—	2.2	—	< .5	—	7.3	—	< .5	ND	ND	.002
4-33	06-20-96	31	LAC/LAC	—	1.4	—	< .5	—	< .5	—	< .5	< .5	1.4	< 1.0	—	—	—
4-34	06-20-96	31	LAC/LAC	2.2	6.7	2.5	8.0	.9	< .5	< .5	< .5	5.5	15	1.0	—	—	—
4-34	06-20-96	31	AVEK/AVEK	2.9	—	2.8	—	2.4	—	< .5	—	8.1	—	—	ND	ND	.005
4-42	06-20-96	31	LAC/LAC	—	2.7	—	3.3	—	< .5	—	< .5	< .5	6.0	3.0	—	—	—
4-13	06-21-96	32	LAC/LAC	—	2.7	—	1.9	—	1.6	—	2.0	< .5	8.2	< 1.0	—	—	—
4-32	06-21-96	32	LAC/LAC	2.6	6.5	2.8	4.5	1.0	3.3	< .5	1.8	6.4	16	< 1.0	—	—	—
4-33	06-21-96	32	LAC/LAC	—	2.3	—	1.6	—	1.1	—	< .5	< .5	5.0	1.1	—	—	—

Table 11. Trihalomethane concentrations, trihalomethane formation potentials, and associated parameters for water samples collected during cycles 1 and 2 of the injection, storage, and recovery study at Lancaster, Antelope Valley, California, April 1995 through January 1998—Continued

Sample collection site (local well name)	Sampling date	Day of cycle phase	Collected by/ analyzed by	CHCl ₃ (µg/L)	CHCl ₃ FP (µg/L)	CHCl ₂ Br (µg/L)	CHCl ₂ Br FP (µg/L)	CHBr ₂ Cl (µg/L)	CHBr ₂ Cl FP (µg/L)	CHBr ₃ (µg/L)	CHBr ₃ FP (µg/L)	TTHM (µg/L)	TTHM FP (µg/L)	Total organic carbon (mg/L)	Free residual chlorine (mg/L)	Total residual chlorine (mg/L)	Ultra-violet absorbance (per cm)
Cycle 1 recovery—Continued																	
4-34	06-21-96	32	LAC/LAC	2.5	5.5	2.7	5.8	1.0	4.4	< 0.5	2.7	6.2	18	< 1.0	—	—	
4-42	06-21-96	32	LAC/LAC	—	2.1	—	2.4	—	1.9	—	<.5	<.5	6.4	< 1.0	—	—	
4-13	06-22-96	33	LAC/LAC	—	2.4	—	1.3	—	<.5	—	<.5	<.5	3.7	< 1.0	—	—	
4-32	06-22-96	33	LAC/LAC	2.1	8.1	2.3	4.8	.8	<.5	<.5	<.5	5.2	13	< 1.0	—	—	
4-33	06-22-96	33	LAC/LAC	—	1.8	—	1.1	—	<.5	—	<.5	<.5	2.9	1.4	—	—	
4-34	06-22-96	33	LAC/LAC	1.9	6.4	3.3	7.7	1.0	<.5	<.5	<.5	6.2	14	2.2	—	—	
4-42	06-22-96	33	LAC/LAC	—	2.9	—	24	—	<.5	—	<.5	<.5	27	< 1.0	—	—	
4-13	06-23-96	34	LAC/LAC	—	4.1	—	4.5	—	2.1	—	1.9	<.5	13	4.9	—	—	
4-32	06-23-96	34	LAC/LAC	1.8	6.5	2.4	5.3	.9	2.8	<.5	<.5	5.1	15	1.9	—	—	
4-33	06-23-96	34	LAC/LAC	—	1.5	—	.9	—	<.5	—	<.5	<.5	2.4	< 1.0	—	—	
4-34	06-23-96	34	LAC/LAC	1.7	2.5	.6	8.4	.9	5.0	<.5	<.5	3.2	16	5.6	—	—	
4-42	06-23-96	34	LAC/LAC	—	3.0	—	3.8	—	2.3	—	<.5	<.5	9.1	2.2	—	—	
4-13	06-24-96	35	LAC/LAC	—	16	—	26	—	2.3	—	<.5	<.5	44	4.2	—	—	
4-32	06-24-96	35	LAC/LAC	2.3	8.4	3.7	5.8	1.4	2.1	<.5	<.5	7.4	16	< 1.0	—	—	
4-33	06-24-96	35	LAC/LAC	—	10	—	15	—	<.5	—	<.5	<.5	25	5.9	—	—	
4-34	06-24-96	35	LAC/LAC	1.6	12	2.8	3.7	.9	7.0	<.5	<.5	5.3	22	2.3	—	—	
4-42	06-24-96	35	LAC/LAC	—	6.5	—	17	—	3.9	—	<.5	<.5	27	1.5	—	—	
4-13	06-25-96	36	LAC/LAC	—	33	—	42	—	2.8	—	<.5	<.5	78	1.7	—	—	
4-32	06-25-96	36	LAC/LAC	1.4	12	1.8	14	<.5	2.9	<.5	<.5	3.2	29	5.5	—	—	
4-33	06-25-96	36	LAC/LAC	—	21	—	22	—	.9	—	<.5	<.5	43	< 1.0	—	—	
4-34	06-25-96	36	LAC/LAC	1.5	13	2.1	29	<.5	6.0	<.5	<.5	3.6	48	< 1.0	—	—	
4-42	06-25-96	36	LAC/LAC	—	48	—	91	—	8.2	—	<.5	<.5	147	1.6	—	—	
4-13	06-26-96	37	LAC/LAC	—	16	—	27	—	2.3	—	1.4	<.5	47	< 1.0	—	—	
4-32	06-26-96	37	LAC/LAC	1.1	19	1.7	15	<.5	1.6	<.5	<.5	2.8	36	< 1.0	—	—	
4-33	06-26-96	37	LAC/LAC	—	27	—	32	—	1.0	—	<.5	<.5	60	2.5	—	—	
4-34	06-26-96	37	LAC/LAC	1.8	16	2.1	41	<.5	4.5	<.5	.6	3.9	63	2.5	—	—	
4-42	06-26-96	37	LAC/LAC	—	29	—	109	—	6.0	—	<.5	<.5	144	1.7	—	—	
4-13	06-27-96	38	LAC/LAC	—	2.8	—	2.0	—	1.2	—	<.5	<.5	6.0	< 1.0	—	—	
4-32	06-27-96	38	LAC/LAC	2.0	6.5	1.2	2.8	1.0	1.5	<.5	<.5	4.2	11	< 1.0	—	—	
4-32	06-27-96	38	AVEK/AVEK	1.9	—	1.8	—	1.7	—	<.5	—	5.4	—	<.5	ND	ND	0.003

Table 11

Table 11. Trihalomethane concentrations, trihalomethane formation potentials, and associated parameters for water samples collected during cycles 1 and 2 of the injection, storage, and recovery study at Lancaster, Antelope Valley, California, April 1995 through January 1998—Continued

Sample collection site (local well name)	Sampling date	Day of cycle phase	Collected by/ analyzed by	CHCl ₃ FP ($\mu\text{g/L}$)	CHCl ₃ FP ($\mu\text{g/L}$)	CHCl ₂ Br FP ($\mu\text{g/L}$)	CHBr ₂ Cl FP ($\mu\text{g/L}$)	CHBr ₂ Cl FP ($\mu\text{g/L}$)	CHBr ₃ FP ($\mu\text{g/L}$)	TTHM FP ($\mu\text{g/L}$)	Total organic carbon (mg/L)	Free residual chlorine (mg/L)	Total residual chlorine (mg/L)	Ultra-violet absorbance (per cm)	
Cycle 1 recovery—Continued															
4-33	06-27-96	38	LAC/LAC	—	2.3	—	1.7	—	0.9	—	<0.5	<0.5	4.9	1.3	—
4-34	06-27-96	38	LAC/LAC	2.1	1.7	1.2	1.0	1.2	2.9	<0.5	<.5	4.5	5.6	2.5	—
4-34	06-27-96	38	AVEK/AVEK	2.2	—	2.0	—	1.9	—	<.5	—	6.1	—	ND	ND
4-42	06-27-96	38	LAC/LAC	—	3.2	—	2.9	—	2.1	—	<.5	<.5	8.2	1.7	—
4-13	06-28-96	39	LAC/LAC	—	3.8	—	1.3	—	1.2	—	<.5	<.5	6.3	<1.0	—
4-32	06-28-96	39	LAC/LAC	1.9	6.7	1.2	2.4	1.2	2.5	<.5	<.5	4.3	11	<1.0	—
4-33	06-28-96	39	LAC/LAC	—	1.4	—	<.5	—	<.5	—	<.5	<.5	1.4	1.5	—
4-34	06-28-96	39	LAC/LAC	2.2	5.5	10	3.1	1.3	3.9	<.5	<.5	4.9	13	2.7	—
4-42	06-28-96	39	LAC/LAC	—	2.9	—	1.7	—	2.2	—	<.5	<.5	6.8	<1.0	—
4-13	06-29-96	40	LAC/LAC	—	3.0	—	2.7	—	1.8	—	1.5	<.5	9.0	1.5	—
4-32	06-29-96	40	LAC/LAC	1.6	4.1	1.3	4.6	1.1	3.6	<.5	<.5	4.0	12	1.7	—
4-33	06-29-96	40	LAC/LAC	—	1.9	—	1.2	—	.8	—	<.5	<.5	3.9	1.9	—
4-34	06-29-96	40	LAC/LAC	1.9	4.2	1.6	4.3	1.3	3.4	<.5	1.4	4.8	13	<1.0	—
4-42	06-29-96	40	LAC/LAC	—	2.9	—	2.4	—	2.3	—	<.5	<.5	7.6	1.3	—
4-13	06-30-96	41	LAC/LAC	—	2.7	—	2.1	—	.9	—	<.5	<.5	5.7	1.8	—
4-32	06-30-96	41	LAC/LAC	1.8	5.2	1.8	4.1	1.0	1.9	<.5	<.5	4.6	11	1.7	—
4-33	06-30-96	41	LAC/LAC	—	1.9	—	1.1	—	.8	—	<.5	<.5	3.8	4.4	—
4-34	06-30-96	41	LAC/LAC	2.0	4.5	1.9	4.6	1.3	2.8	<.5	<.5	5.2	12	<1.0	—
4-42	06-30-96	41	LAC/LAC	—	3.3	—	2.9	—	1.8	—	<.5	<.5	8.0	<1.0	—
4-13	07-01-96	42	LAC/LAC	—	4.6	—	3.7	—	1.7	—	<.5	<.5	10	3.2	—
4-32	07-01-96	42	LAC/LAC	1.7	5.5	1.1	4.1	.8	2.1	<.5	1.2	3.6	13	<1.0	—
4-33	07-01-96	42	LAC/LAC	—	4.0	—	2.2	—	.8	—	<.5	<.5	7.0	1.2	—
4-34	07-01-96	42	LAC/LAC	1.8	5.4	1.0	2.0	.8	2.4	<.5	1.2	3.6	11	2.0	—
4-42	07-01-96	42	LAC/LAC	—	3.8	—	1.0	—	2.5	—	<.5	<.5	7.3	1.4	—
4-13	07-02-96	43	LAC/LAC	—	4.1	—	2.3	—	.5	—	<.5	<.5	6.9	1.6	—
4-32	07-02-96	43	LAC/LAC	1.5	6.4	1.4	2.0	.8	<.5	<.5	3.7	8.4	<1.0	—	—
4-33	07-02-96	43	LAC/LAC	—	2.5	—	1.5	—	.6	—	<.5	<.5	4.6	4.7	—
4-34	07-02-96	43	LAC/LAC	1.8	4.2	1.7	1.4	1.0	1.1	<.5	<.5	4.5	6.7	2.5	—
4-42	07-02-96	43	LAC/LAC	—	4.6	—	4.3	—	1.5	—	<.5	<.5	10	<1.0	—
4-13	07-03-96	44	LAC/LAC	—	3.8	—	3.7	—	1.0	—	<.5	<.5	8.5	2.0	—

Table 11. Trihalomethane concentrations, trihalomethane formation potentials, and associated parameters for water samples collected during cycles 1 and 2 of the injection, storage, and recovery study at Lancaster, Antelope Valley, California, April 1995 through January 1998—Continued

Sample collection site (local well name)	Sampling date	Day of cycle phase	Collected by/ analyzed by	CHCl ₃ (µg/L)	CHCl ₃ FP (µg/L)	CHCl ₂ Br (µg/L)	CHCl ₂ Br FP (µg/L)	CHBr ₂ Cl (µg/L)	CHBr ₂ Cl FP (µg/L)	CHBr ₃ (µg/L)	CHBr ₃ FP (µg/L)	TTHM (µg/L)	TTHM FP (µg/L)	Total organic carbon (mg/L)	Free residual chlorine (mg/L)	Total residual chlorine (mg/L)	Ultra-violet absorbance (per cm)
Cycle 1 recovery—Continued																	
4-32	07-03-96	44	LAC/LAC	1.3	5.2	0.8	4.3	0.9	1.8	0.2	<0.5	3.2	11	4.3	—	—	—
4-32	07-03-96	44	AVEK/AVEK	1.7	—	1.5	—	1.7	—	<.5	—	4.9	—	—	ND	ND	.003
4-33	07-03-96	44	LAC/LAC	—	3.1	—	1.8	—	<.5	—	<.5	<.5	4.9	1.9	—	—	—
4-34	07-03-96	44	LAC/LAC	1.7	5.2	.9	5.9	.9	2.8	.2	<.5	3.7	14	1.9	—	—	—
4-34	07-03-96	44	AVEK/AVEK	2.0	—	1.8	—	1.9	—	<.5	—	5.7	—	—	ND	ND	.005
4-42	07-03-96	44	LAC/LAC	—	3.3	—	1.2	—	<.5	—	<.5	<.5	4.5	1.6	—	—	—
4-13	07-04-96	45	LAC/LAC	—	3.5	—	2.8	—	<.5	—	<.5	<.5	6.3	1.4	—	—	—
4-32	07-04-96	45	LAC/LAC	1.2	7.7	.7	6.3	.6	1.6	<.5	<.5	2.5	16	<1.0	—	—	—
4-33	07-04-96	45	LAC/LAC	—	2.0	—	1.2	—	<.5	—	<.5	<.5	3.2	2.6	—	—	—
4-34	07-04-96	45	LAC/LAC	1.6	4.2	1.0	4.7	.8	2.2	<.5	<.5	3.4	11	3.5	—	—	—
4-42	07-04-96	45	LAC/LAC	—	3.6	—	4.6	—	1.4	—	<.5	<.5	9.6	1.4	—	—	—
4-13	07-05-96	46	LAC/LAC	—	3.3	—	3.3	—	1.4	—	<.5	<.5	8.0	<1.0	—	—	—
4-32	07-05-96	46	LAC/LAC	1.4	6.7	1.2	4.0	.7	1.9	<.5	1.6	3.3	14	<1.0	—	—	—
4-33	07-05-96	46	LAC/LAC	—	2.4	—	2.1	—	<.5	—	<.5	<.5	4.5	3.0	—	—	—
4-34	07-05-96	46	LAC/LAC	1.8	5.4	1.6	1.7	1.2	2.3	<.5	<.5	4.6	9.4	3.0	—	—	—
4-42	07-05-96	46	LAC/LAC	—	3.1	—	4.0	—	2.3	—	<.5	<.5	9.4	<1.0	—	—	—
4-13	07-06-96	47	LAC/LAC	—	3.6	—	3.1	—	.8	—	<.5	<.5	7.5	<1.0	—	—	—
4-32	07-06-96	47	LAC/LAC	1.3	6.0	1.3	4.5	1.6	<.5	<.5	<.5	4.2	11	1.6	—	—	—
4-33	07-06-96	47	LAC/LAC	—	3.0	—	1.7	—	<.5	—	<.5	<.5	4.7	<1.0	—	—	—
4-34	07-06-96	47	LAC/LAC	1.5	4.8	1.4	4.7	1.4	2.8	<.5	<.5	4.3	12	2.4	—	—	—
4-42	07-06-96	47	LAC/LAC	—	3.3	—	4.0	—	<.5	—	<.5	<.5	7.3	1.6	—	—	—
4-13	07-07-96	48	LAC/LAC	—	2.8	—	.7	—	1.2	—	<.5	<.5	4.7	1.1	—	—	—
4-32	07-07-96	48	LAC/LAC	1.3	3.4	1.5	2.8	1.3	2.6	<.5	<.5	4.1	8.8	<1.0	—	—	—
4-33	07-07-96	48	LAC/LAC	—	2.5	—	.6	—	<.5	—	<.5	<.5	3.1	<1.0	—	—	—
4-34	07-07-96	48	LAC/LAC	1.3	1.9	1.4	3.5	1.7	2.6	<.5	<.5	4.4	8.0	<1.0	—	—	—
4-42	07-07-96	48	LAC/LAC	—	3.8	—	4.0	—	2.8	—	<.5	<.5	11	<1.0	—	—	—
4-32	07-11-96	52	AVEK/AVEK	1.7	—	1.5	—	1.6	—	<.5	—	4.8	—	—	ND	ND	.003
4-34	07-11-96	52	AVEK/AVEK	1.4	—	1.3	—	1.5	—	<.5	<.5	4.2	—	—	ND	ND	.002
4-13	07-12-96	53	LAC/LAC	—	3.7	—	3.0	—	1.1	—	.8	<.5	8.6	2.5	—	—	—
4-32	07-12-96	53	LAC/LAC	1.3	4.4	1.2	4.6	1.1	1.5	<.5	<.5	3.6	9.3	4.3	—	—	—

Table 11

Table 11. Trihalomethane concentrations, trihalomethane formation potentials, and associated parameters for water samples collected during cycles 1 and 2 of the injection, storage, and recovery study at Lancaster, Antelope Valley, California, April 1995 through January 1998—Continued

Sample collection site (local well name)	Sampling date	Day of cycle phase	Collected by/ analyzed by	CHCl ₃ ($\mu\text{g/L}$)	CHCl ₃ FP ($\mu\text{g/L}$)	CHCl ₂ Br ($\mu\text{g/L}$)	CHCl ₂ Br FP ($\mu\text{g/L}$)	CHBr ₂ Cl ($\mu\text{g/L}$)	CHBr ₂ Cl FP ($\mu\text{g/L}$)	CHBr ₃ ($\mu\text{g/L}$)	CHBr ₃ FP ($\mu\text{g/L}$)	TTHM ($\mu\text{g/L}$)	TTHM FP ($\mu\text{g/L}$)	Total organic carbon (mg/L)	Free residual chlorine (mg/L)	Total residual chlorine (mg/L)	Ultra-violet absorbance (per cm)
Cycle 1 recovery—Continued																	
4-33	07-12-96	53	LAC/LAC	—	3.2	—	1.4	—	<0.5	—	<0.5	<0.5	4.6	72	—	—	—
4-34	07-12-96	53	LAC/LAC	1.2	4.7	1.2	4.3	0.7	1.9	<0.5	<.5	3.1	11	1.8	—	—	—
4-42	07-12-96	53	LAC/LAC	—	4.4	—	4.0	—	2.4	—	<.5	<.5	11	44	—	—	—
4-32	07-18-96	59	AVEK/AVEK	1.4	—	1.2	—	1.5	—	<.5	—	4.1	—	—	ND	ND	0.000
4-34	07-18-96	59	AVEK/AVEK	1.5	—	1.3	—	1.5	—	<.5	<.5	4.3	—	—	ND	ND	.005
4-13	07-19-96	60	LAC/LAC	—	3.4	—	<.5	—	1.1	—	<.5	<.5	4.5	2.9	—	—	—
4-32	07-19-96	60	LAC/LAC	.8	4.5	.9	1.3	<.5	1.6	<.5	.6	1.7	8.0	4.2	—	—	—
4-33	07-19-96	60	LAC/LAC	—	2.4	—	<.5	—	<.5	—	<.5	—	2.4	1.9	—	—	—
4-34	07-19-96	60	LAC/LAC	.9	4.8	.9	<.5	<.5	2.1	<.5	<.5	1.8	6.9	1.0	—	—	—
4-42	07-19-96	60	LAC/LAC	—	4.0	—	1.5	—	5.8	—	<.5	—	11	2.0	—	—	—
4-13	07-25-96	66	LAC/LAC	—	—	—	—	—	—	—	—	<.5	7.2	2.2	—	—	—
4-32	07-25-96	66	LAC/LAC	—	—	—	—	—	—	—	—	—	2.8	12.1	<1.0	—	—
4-33	07-25-96	66	LAC/LAC	—	—	—	—	—	—	—	—	—	<.5	3.6	3.5	—	—
4-42	07-25-96	66	LAC/LAC	—	—	—	—	—	—	—	—	—	<.5	9.1	4.1	—	—
4-5	07-26-96	67	LAC/LAC	—	—	—	—	—	—	—	—	—	<.5	—	—	—	—
4-9	07-26-96	67	LAC/LAC	—	—	—	—	—	—	—	—	—	<.5	—	—	—	—
4-12	07-26-96	67	LAC/LAC	—	—	—	—	—	—	—	—	—	<.5	—	—	—	—
4-17	07-26-96	67	LAC/LAC	—	—	—	—	—	—	—	—	—	<.5	—	—	—	—
4-25	07-26-96	67	LAC/LAC	—	—	—	—	—	—	—	—	—	<.5	—	—	—	—
4-26	07-26-96	67	LAC/LAC	—	—	—	—	—	—	—	—	—	<.5	—	—	—	—
4-37	07-26-96	67	LAC/LAC	—	—	—	—	—	—	—	—	—	<.5	—	—	—	—
4-38	07-26-96	67	LAC/LAC	—	—	—	—	—	—	—	—	—	<.5	—	—	—	—
4-13	08-01-96	73	LAC/LAC	—	—	—	—	—	—	—	—	—	<.5	—	1.6	—	—
4-32	08-01-96	73	LAC/LAC	—	—	—	—	—	—	—	—	—	1.1	—	1.3	—	—
4-33	08-01-96	73	LAC/LAC	—	—	—	—	—	—	—	—	—	<.5	—	1.3	—	—
4-42	08-01-96	73	LAC/LAC	—	—	—	—	—	—	—	—	—	<.5	—	—	—	—
4-13	08-08-96	80	LAC/LAC	—	—	—	—	—	—	—	—	—	<.5	—	1.6	—	—
4-32	08-08-96	80	LAC/LAC	—	—	—	—	—	—	—	—	—	1.1	—	2.7	—	—
4-33	08-08-96	80	LAC/LAC	—	—	—	—	—	—	—	—	—	<.5	—	—	—	—
4-42	08-08-96	80	LAC/LAC	—	—	—	—	—	—	—	—	—	<.5	—	—	—	—

Table 11. Trihalomethane concentrations, trihalomethane formation potentials, and associated parameters for water samples collected during cycles 1 and 2 of the injection, storage, and recovery study at Lancaster, Antelope Valley, California, April 1995 through January 1998—Continued

Sample collection site (local well name)	Sampling date	Day of cycle phase	Collected by/ analyzed by	CHCl ₃ (µg/L)	CHCl ₃ FP (µg/L)	CHCl ₂ Br (µg/L)	CHCl ₂ Br FP (µg/L)	CHBr ₂ Cl (µg/L)	CHBr ₂ Cl FP (µg/L)	CHBr ₃ (µg/L)	CHBr ₃ FP (µg/L)	TTHM (µg/L)	TTHM FP (µg/L)	Total organic carbon (mg/L)	Free residual chlorine (mg/L)	Total residual chlorine (mg/L)	Ultra-violet absorbance (per cm)
Cycle 1 recovery—Continued																	
4-13	08-15-96	87	LAC/LAC	—	—	—	—	—	—	—	—	<0.5	—	1.1	—	—	—
4-32	08-15-96	87	LAC/LAC	—	—	—	—	—	—	—	—	1.2	—	3.2	—	—	—
4-42	08-15-96	87	LAC/LAC	—	—	—	—	—	—	—	—	<.5	—	—	—	—	—
4-13	08-22-96	94	LAC/LAC	—	—	—	—	—	—	—	—	<.5	—	2.0	—	—	—
4-32	08-22-96	94	LAC/LAC	—	—	—	—	—	—	—	—	<.5	—	1.8	—	—	—
4-42	08-22-96	94	LAC/LAC	—	—	—	—	—	—	—	—	<.5	—	—	—	—	—
Cycle 2 pre-injection																	
5K8-PZ1	10-31-96	11	USGS/LAC	<0.5	—	<0.5	—	<0.5	—	<0.5	—	<0.5	—	—	—	—	—
5K8-PZ2	10-31-96	11	USGS/LAC	<.5	—	<.5	—	<.5	—	<.5	—	<.5	—	—	—	—	—
5K8-PZ3	10-31-96	11	USGS/LAC	<.5	—	<.5	—	<.5	—	<.5	—	<.5	—	—	—	—	—
5K8-PZ4	10-31-96	11	USGS/LAC	<.5	—	<.5	—	<.5	—	<.5	—	<.5	—	—	—	—	—
4-5	10-31-96	11	LAC/LAC	<.5	—	<.5	—	<.5	—	<.5	—	<.5	—	—	—	—	—
4-9	10-31-96	11	LAC/LAC	<.5	—	<.5	—	<.5	—	<.5	—	<.5	—	—	—	—	—
4-25	10-31-96	11	LAC/LAC	<.5	—	<.5	—	<.5	—	<.5	—	<.5	—	—	—	—	—
4-26	10-31-96	11	LAC/LAC	<.5	—	<.5	—	<.5	—	<.5	—	<.5	—	—	—	—	—
4-29	10-31-96	11	LAC/LAC	<.5	—	<.5	—	<.5	—	<.5	—	<.5	—	—	—	—	—
4-37	10-31-96	11	LAC/LAC	<.5	—	<.5	—	<.5	—	<.5	—	<.5	—	—	—	—	—
4-38	10-31-96	11	LAC/LAC	<.5	—	<.5	—	<.5	—	<.5	—	<.5	—	—	—	—	—
4-44	10-31-96	11	LAC/LAC	<.5	—	<.5	—	<.5	—	<.5	—	<.5	—	—	—	—	—
4-12	11-01-96	12	LAC/LAC	<.5	—	<.5	—	<.5	—	<.5	—	<.5	—	—	—	—	—
4-13	11-01-96	12	LAC/LAC	<.5	—	<.5	—	<.5	—	<.5	—	<.5	—	—	—	—	—
4-17	11-01-96	12	LAC/LAC	<.5	—	<.5	—	<.5	—	<.5	—	<.5	—	—	—	—	—
4-30	11-01-96	12	LAC/LAC	<.5	—	<.5	—	<.5	—	<.5	—	<.5	—	—	—	—	—
4-32	11-01-96	12	LAC/LAC	4.2	—	3.6	—	1.8	—	<.5	—	9.6	—	—	—	—	—
4-32	11-01-96	12	AVEK/AVEK	6.8	—	6.6	—	5.4	—	1.6	—	20	—	0.9	—	—	0.014
4-33	11-01-96	12	LAC/LAC	<.5	—	<.5	—	<.5	—	<.5	—	<.5	—	—	—	—	—
4-34	11-01-96	12	LAC/LAC	.7	—	<.5	—	<.5	—	<.5	—	<.5	—	.7	—	—	—
4-34	11-01-96	12	AVEK/AVEK	.9	—	.8	—	.9	—	<.5	—	2.6	—	.5	—	—	.003
4-42	11-01-96	12	LAC/LAC	<.5	—	<.5	—	<.5	—	<.5	—	<.5	—	—	—	—	—
4-43	11-01-96	12	LAC/LAC	<.5	—	<.5	—	<.5	—	<.5	—	<.5	—	—	—	—	—
DK8-PZ1	11-07-96	18	USGS/LAC	<.5	—	<.5	—	<.5	—	<.5	—	<.5	—	<.5	—	—	—

Table 11

Table 11. Trihalomethane concentrations, trihalomethane formation potentials, and associated parameters for water samples collected during cycles 1 and 2 of the injection, storage, and recovery study at Lancaster, Antelope Valley, California, April 1995 through January 1998—Continued

Sample collection site (local well name)	Sampling date	Day of cycle phase	Collected by/ analyzed by	CHCl ₃ (µg/L)	CHCl ₃ FP (µg/L)	CHCl ₂ Br (µg/L)	CHCl ₂ Br FP (µg/L)	CHBr ₂ Cl (µg/L)	CHBr ₂ Cl FP (µg/L)	CHBr ₃ (µg/L)	CHBr ₃ FP (µg/L)	TTHM (µg/L)	TTHM FP (µg/L)	Total organic carbon (mg/L)	Free residual chlorine (mg/L)	Total residual chlorine (mg/L)	Ultra-violet absorbance (per cm)
Cycle 2 injection																	
4-32 (AVEK)	11-12-96	1	LAC/LAC	9.5	—	15	—	12	—	< 0.5	—	36	—	—	—	0.83	—
4-34 (AVEK)	11-12-96	1	LAC/LAC	6.2	—	9.3	—	7.0	—	<.5	—	23	—	—	—	—	—
4-32 (AVEK)	11-12-96	1	AVEK/AVEK	9.6	—	11	—	10	—	1.8	—	32	—	1.8	0.50	.70	0.019
4-32 (AVEK)	11-21-96	10	LAC/LAC	9.3	—	13	—	9.0	—	<.5	—	31	—	—	—	.93	—
4-34 (AVEK)	11-21-96	10	LAC/LAC	—	—	—	—	—	—	—	—	30	—	—	—	.94	—
4-32 (AVEK)	11-21-96	10	AVEK/AVEK	8.9	—	11	—	10	—	2.0	—	32	—	1.8	.45	.60	.015
4-32 (AVEK)	11-27-96	16	LAC/LAC	6.8	—	7.5	—	8.5	—	<.5	—	23	—	—	—	.97	—
4-34 (AVEK)	11-27-96	16	LAC/LAC	—	—	—	—	—	—	—	—	24	—	—	—	.96	—
4-32 (AVEK)	11-27-96	16	AVEK/AVEK	9.3	—	11	—	12	—	2.3	—	35	—	1.9	.50	.70	.021
4-32 (AVEK)	12-05-96	24	LAC/LAC	3.9	—	6.2	—	11	—	1.3	—	23	—	—	—	.96	—
4-34 (AVEK)	12-05-96	24	LAC/LAC	—	—	—	—	—	—	—	—	22	—	—	—	.96	—
4-32 (AVEK)	12-05-96	24	AVEK/AVEK	5.5	—	8.4	—	11	—	2.7	—	28	—	1.9	.50	.70	.019
4-32 (AVEK)	12-12-96	31	LAC/LAC	4.8	—	9.2	—	12	—	1.8	—	28	—	—	—	.81	—
4-34 (AVEK)	12-12-96	31	LAC/LAC	—	—	—	—	—	—	—	—	28	—	—	—	.86	—
4-32 (AVEK)	12-12-96	31	AVEK/AVEK	6.4	—	9.9	—	15	—	3.4	—	34	—	1.8	.50	.70	.019
4-32 (AVEK)	12-19-96	38	LAC/LAC	4.4	—	10	—	12	—	1.6	—	29	—	—	—	.84	—
4-34 (AVEK)	12-19-96	38	LAC/LAC	—	—	—	—	—	—	—	—	32	—	—	—	.84	—
4-32 (AVEK)	12-19-96	38	AVEK/AVEK	3.0	—	8.0	—	20	—	9.6	—	40	—	1.6	.55	.70	.021
4-32 (AVEK)	12-26-96	45	LAC/LAC	2.8	—	7.7	—	13	—	4.2	—	28	—	—	—	.86	—
4-34 (AVEK)	12-26-96	45	LAC/LAC	—	—	—	—	—	—	—	—	33	—	—	—	.87	—
4-32 (AVEK)	12-26-96	45	AVEK/AVEK	3.7	—	8.7	—	19	—	7.9	—	40	—	1.6	.50	.70	.022
4-32 (AVEK)	01-02-97	52	LAC/LAC	2.3	—	8.2	—	19	—	7.4	—	37	—	—	—	.84	—
4-34 (AVEK)	01-02-97	52	LAC/LAC	—	—	—	—	—	—	—	—	41	—	—	—	.85	—
4-32 (AVEK)	01-02-97	52	AVEK/AVEK	3.5	—	9.5	—	23	—	12.2	—	48	—	1.7	.50	.70	.023
4-32 (AVEK)	01-09-97	59	LAC/LAC	7.2	—	8.1	—	16	—	9.0	—	40	—	—	—	.78	—
4-34 (AVEK)	01-09-97	59	LAC/LAC	7.4	—	8.1	—	18	—	8.8	—	43	—	—	—	.81	—
4-32 (AVEK)	01-09-97	59	AVEK/AVEK	3.5	—	9.4	—	23	—	13.3	—	50	—	1.9	.40	.60	.023
4-32 (AVEK)	01-16-97	66	LAC/LAC	3.8	—	10	—	17	—	6.2	—	37	—	—	—	.74	—
4-34 (AVEK)	01-16-97	66	LAC/LAC	—	—	—	—	—	—	—	—	44	—	—	—	.74	—
4-32 (AVEK)	01-16-97	66	AVEK/AVEK	4.7	—	11	—	21	—	8.8	—	45	—	1.5	.40	.60	.020

Table 11. Trihalomethane concentrations, trihalomethane formation potentials, and associated parameters for water samples collected during cycles 1 and 2 of the injection, storage, and recovery study at Lancaster, Antelope Valley, California, April 1995 through January 1998—Continued

Sample collection site (local well name)	Sampling date	Day of cycle phase	Collected by/ analyzed by	CHCl ₃ (µg/L)	CHCl ₃ FP (µg/L)	CHCl ₂ Br (µg/L)	CHCl ₂ Br FP (µg/L)	CHBr ₂ Cl (µg/L)	CHBr ₂ Cl FP (µg/L)	CHBr ₃ (µg/L)	CHBr ₃ FP (µg/L)	TTHM (µg/L)	TTHM FP (µg/L)	Total organic carbon (mg/L)	Free residual chlorine (mg/L)	Total residual chlorine (mg/L)	Ultra-violet absorbance (per cm)
Cycle 2 injection—Continued																	
4-32 (AVEK)	01-23-97	73	LAC/LAC	3.8	—	9.7	—	16	—	< 0.5	—	29	—	—	—	0.78	—
4-34 (AVEK)	01-23-97	73	LAC/LAC	—	—	—	—	—	—	—	—	35	—	—	—	.78	—
4-32 (AVEK)	01-23-97	73	AVEK/AVEK	4.6	—	10	—	20	—	7.5	—	42	—	1.6	0.30	.50	0.027
4-32 (AVEK)	01-30-97	80	AVEK/AVEK	10	—	14	—	16	—	3.1	—	44	—	1.9	.50	.70	.031
4-32 (AVEK)	01-31-97	81	LAC/LAC	7.1	—	13	—	13	—	<.5	—	32	—	—	—	.86	—
4-34 (AVEK)	01-31-97	81	LAC/LAC	—	—	—	—	—	—	—	—	35	—	—	—	.85	—
4-5	02-05-97	86	LAC/LAC	<.5	—	<.5	—	<.5	—	<.5	—	<.5	—	—	—	—	—
4-9	02-05-97	86	LAC/LAC	<.5	—	<.5	—	<.5	—	<.5	—	<.5	—	—	—	—	—
4-12	02-05-97	86	LAC/LAC	<.5	—	<.5	—	<.5	—	<.5	—	<.5	—	—	—	—	—
4-13	02-05-97	86	LAC/LAC	<.5	—	<.5	—	<.5	—	<.5	—	<.5	—	—	—	—	—
4-17	02-05-97	86	LAC/LAC	<.5	—	<.5	—	<.5	—	<.5	—	<.5	—	—	—	—	—
4-25	02-05-97	86	LAC/LAC	<.5	—	<.5	—	<.5	—	<.5	—	<.5	—	—	—	—	—
4-26	02-05-97	86	LAC/LAC	<.5	—	<.5	—	<.5	—	<.5	—	<.5	—	—	—	—	—
4-29	02-05-97	86	LAC/LAC	<.5	—	<.5	—	<.5	—	<.5	—	<.5	—	—	—	—	—
4-30	02-05-97	86	LAC/LAC	<.5	—	<.5	—	<.5	—	<.5	—	<.5	—	—	—	—	—
4-33	02-05-97	86	LAC/LAC	<.5	—	<.5	—	<.5	—	<.5	—	<.5	—	—	—	—	—
4-37	02-05-97	86	LAC/LAC	<.5	—	<.5	—	<.5	—	<.5	—	<.5	—	—	—	—	—
4-38	02-05-97	86	LAC/LAC	<.5	—	<.5	—	<.5	—	<.5	—	<.5	—	—	—	—	—
4-42	02-05-97	86	LAC/LAC	<.5	—	<.5	—	<.5	—	<.5	—	<.5	—	—	—	—	—
4-43	02-05-97	86	LAC/LAC	<.5	—	<.5	—	<.5	—	<.5	—	<.5	—	—	—	—	—
4-44	02-06-97	87	LAC/LAC	<.5	—	<.5	—	<.5	—	<.5	—	<.5	—	—	—	—	—
4-32 (AVEK)	02-06-97	87	LAC/LAC	9.8	—	16	—	17	—	3.0	—	46	—	—	—	.92	—
4-34 (AVEK)	02-06-97	87	LAC/LAC	—	—	—	—	—	—	—	—	49	—	—	—	.94	—
4-32 (AVEK)	02-06-97	87	AVEK/AVEK	11	—	14	—	18	—	3.2	—	46	—	1.8	.50	.70	.032
4-32 (AVEK)	02-13-97	94	LAC/LAC	6.1	—	17	—	23	—	6.7	—	53	—	—	—	.84	—
4-34 (AVEK)	02-13-97	94	LAC/LAC	7.3	—	18	—	13	—	6.2	—	44	—	—	—	—	—
4-32 (AVEK)	02-13-97	94	AVEK/AVEK	7.8	—	13	—	21	—	5.3	—	48	—	1.7	.40	.60	.022
4-32 (AVEK)	02-20-97	101	LAC/LAC	6.0	—	16	—	17	—	6.4	—	45	—	—	—	.95	—
4-34 (AVEK)	02-20-97	101	LAC/LAC	—	—	—	—	—	—	—	—	43	—	—	—	.96	—
4-32 (AVEK)	02-20-97	101	AVEK/AVEK	8.7	—	14	—	22	—	6.3	—	51	—	2.4	.60	.80	.018

Table 11

Table 11. Trihalomethane concentrations, trihalomethane formation potentials, and associated parameters for water samples collected during cycles 1 and 2 of the injection, storage, and recovery study at Lancaster, Antelope Valley, California, April 1995 through January 1998—Continued

Sample collection site (local well name)	Sampling date	Day of cycle phase	Collected by/ analyzed by	CHCl ₃ (µg/L)	CHCl ₃ FP (µg/L)	CHCl ₂ Br (µg/L)	CHCl ₂ Br FP (µg/L)	CHBr ₂ Cl (µg/L)	CHBr ₂ Cl FP (µg/L)	CHBr ₃ (µg/L)	CHBr ₃ FP (µg/L)	TTHM (µg/L)	TTHM FP (µg/L)	Total organic carbon (mg/L)	Free residual chlorine (mg/L)	Total residual chlorine (mg/L)	Ultra-violet absorbance (per cm)
Cycle 2 injection—Continued																	
4-32 (AVEK)	02-27-97	108	LAC/LAC	6.3	—	16	—	17	—	5.1	—	44	—	—	—	1.2	—
4-34 (AVEK)	02-27-97	108	LAC/LAC	—	—	—	—	—	—	—	—	46	—	—	—	1.2	—
4-32 (AVEK)	02-27-97	108	AVEK/AVEK	11	—	16	—	23	—	6.2	—	56	—	2.8	0.80	1.0	0.018
4-32 (AVEK)	03-06-97	115	LAC/LAC	22	—	6.3	—	.8	—	<.5	—	30	—	—	—	1.0	—
4-34 (AVEK)	03-06-97	115	LAC/LAC	—	—	—	—	—	—	—	—	32	—	—	—	—	—
4-32 (AVEK)	03-06-97	115	AVEK/AVEK	26	—	5.1	—	1.5	—	<.5	—	33	—	2.2	.40	.60	.030
4-32 (AVEK)	03-13-97	122	LAC/LAC	—	—	—	—	—	—	<.5	—	22	—	—	—	.83	—
4-32 (AVEK)	03-13-97	122	AVEK/AVEK	25	—	3.7	—	1.0	—	<.5	—	29	—	2.0	.80	1.0	.023
4-32 (AVEK)	03-20-97	129	LAC/LAC	—	—	—	—	—	—	<.5	—	21	—	—	—	.83	—
4-34 (AVEK)	03-20-97	129	LAC/LAC	—	—	—	—	—	—	—	—	32	—	—	—	.83	—
4-32 (AVEK)	03-20-97	129	AVEK/AVEK	8.9	—	9.6	—	9.6	—	2.0	—	30	—	1.4	.70	.90	.021
4-32 (AVEK)	03-27-97	136	LAC/LAC	—	—	—	—	—	—	<.5	—	34	—	—	—	.81	—
4-34 (AVEK)	03-27-97	136	LAC/LAC	—	—	—	—	—	—	—	—	35	—	—	—	.80	—
4-32 (AVEK)	03-27-97	136	AVEK/AVEK	—	—	—	—	—	—	—	—	—	—	1.5	.40	.60	.023
4-32 (AVEK)	04-03-97	143	LAC/LAC	—	—	—	—	—	—	<.5	—	51	—	—	—	.85	—
4-34 (AVEK)	04-03-97	143	LAC/LAC	—	—	—	—	—	—	—	—	38	—	—	—	.85	—
4-32 (AVEK)	04-03-97	143	AVEK/AVEK	9.7	—	11	—	13	—	2.5	—	36	—	1.6	.50	.70	.028
4-32 (AVEK)	04-10-97	150	LAC/LAC	—	—	—	—	—	—	<.5	—	43	—	—	—	.82	—
4-32 (AVEK)	04-10-97	150	AVEK/AVEK	9.8	—	13	—	16	—	3.0	—	42	—	1.9	.50	.70	.032
4-32 (AVEK)	04-17-97	157	LAC/LAC	—	—	—	—	—	—	<.5	—	62	—	—	—	.79	—
4-34 (AVEK)	04-17-97	157	LAC/LAC	—	—	—	—	—	—	—	—	57	—	—	—	.79	—
4-32 (AVEK)	04-17-97	157	AVEK/AVEK	10	—	14	—	18	—	3.5	—	46	—	1.9	.50	.70	.035
Cycle 2 storage																	
5K8-PZ1	05-06-97	20	USGS/LAC	<0.5	—	<0.5	—	<0.5	—	<0.5	—	<0.5	—	—	—	—	—
5K8-PZ2	05-06-97	20	USGS/LAC	<.5	—	<.5	—	<.5	—	<.5	—	<.5	—	—	—	—	—
5K8-PZ3	05-06-97	20	USGS/LAC	<.5	—	<.5	—	<.5	—	<.5	—	<.5	—	—	—	—	—
5K8-PZ4	05-06-97	20	USGS/LAC	<.5	—	<.5	—	<.5	—	<.5	—	<.5	—	—	—	—	—
4-5	05-06-97	20	LAC/LAC	<.5	—	<.5	—	<.5	—	<.5	—	<.5	—	—	—	—	—

Table 11. Trihalomethane concentrations, trihalomethane formation potentials, and associated parameters for water samples collected during cycles 1 and 2 of the injection, storage, and recovery study at Lancaster, Antelope Valley, California, April 1995 through January 1998—Continued

Sample collection site (local well name)	Sampling date	Day of cycle phase	Collected by/ analyzed by	CHCl ₃ (µg/L)	CHCl ₃ FP (µg/L)	CHCl ₂ Br (µg/L)	CHCl ₂ Br FP (µg/L)	CHBr ₂ Cl (µg/L)	CHBr ₂ Cl FP (µg/L)	CHBr ₃ (µg/L)	CHBr ₃ FP (µg/L)	TTHM (µg/L)	TTHM FP (µg/L)	Total organic carbon (mg/L)	Free residual chlorine (mg/L)	Total residual chlorine (mg/L)	Ultra-violet absorbance (per cm)
Cycle 2 storage—Continued																	
4-9	05-06-97	20	LAC/LAC	< 0.5	—	< 0.5	—	< 0.5	—	< 0.5	—	< 0.5	—	—	—	—	
4-12	05-06-97	20	LAC/LAC	< .5	—	< .5	—	< .5	—	< .5	—	< .5	—	—	—	—	
4-25	05-06-97	20	LAC/LAC	< .5	—	< .5	—	< .5	—	< .5	—	< .5	—	—	—	—	
4-26	05-06-97	20	LAC/LAC	< .5	—	< .5	—	< .5	—	< .5	—	< .5	—	—	—	—	
4-37	05-06-97	20	LAC/LAC	< .5	—	< .5	—	< .5	—	< .5	—	< .5	—	—	—	—	
4-38	05-06-97	20	LAC/LAC	< .5	—	< .5	—	< .5	—	< .5	—	< .5	—	—	—	—	
4-29	05-07-97	21	LAC/LAC	< .5	—	< .5	—	< .5	—	< .5	—	< .5	—	—	—	—	
4-30	05-07-97	21	LAC/LAC	< .5	—	< .5	—	< .5	—	< .5	—	< .5	—	—	—	—	
4-34	05-07-97	21	LAC/LAC	24	—	26	—	22	—	3.8	—	76	—	—	—	—	
4-43	05-07-97	21	LAC/LAC	< .5	—	< .5	—	< .5	—	< .5	—	< .5	—	—	—	—	
DK8-PZ1	05-08-97	22	USGS/LAC	< .5	—	< .5	—	< .5	—	< .5	—	< .5	—	—	—	—	
4-17	05-08-97	22	LAC/LAC	< .5	—	< .5	—	< .5	—	< .5	—	< .5	—	—	—	—	
4-44	05-08-97	22	LAC/LAC	< .5	—	< .5	—	< .5	—	< .5	—	< .5	—	—	—	—	
4-13	05-09-97	23	LAC/LAC	2.3	—	2.0	—	1.7	—	< .5	—	6.0	—	—	—	—	
4-33	05-09-97	23	LAC/LAC	< .5	—	< .5	—	< .5	—	< .5	—	< .5	—	—	—	—	
4-42	05-09-97	23	LAC/LAC	< .5	—	< .5	—	< .5	—	< .5	—	< .5	—	—	—	—	
Cycle 2 recovery																	
4-13	05-14-97	1	LAC/LAC	—	—	—	—	—	—	—	—	< 0.5	—	—	< 0.10	—	
4-32	05-14-97	1	LAC/LAC	48	—	39	—	30	—	11	—	127	—	—	.32	—	
4-33	05-14-97	1	LAC/LAC	—	—	—	—	—	—	—	—	< .5	—	—	< .10	—	
4-34	05-14-97	1	LAC/LAC	22	—	24	—	25	—	4.8	—	75	—	—	< .10	—	
4-42	05-14-97	1	LAC/LAC	—	—	—	—	—	—	—	—	< .5	—	—	< .10	—	
4-13	05-15-97	2	LAC/LAC	—	—	—	—	—	—	—	—	.5	—	—	< .10	—	
4-32	05-15-97	2	LAC/LAC	25	—	27	—	27	—	5.6	—	85	—	—	< .10	—	
4-33	05-15-97	2	LAC/LAC	—	—	—	—	—	—	—	—	< .5	—	—	< .10	—	
4-34	05-15-97	2	LAC/LAC	23	—	25	—	22	—	5.1	—	75	—	—	< .10	—	
4-42	05-15-97	2	LAC/LAC	—	—	—	—	—	—	—	—	< .5	—	—	< .10	—	
4-13	05-16-97	3	LAC/LAC	—	—	—	—	—	—	—	—	.7	—	—	< .10	—	
4-32	05-16-97	3	LAC/LAC	22	—	28	—	26	—	5.1	—	81	—	—	< .10	—	
4-32	05-16-97	3	AVEK/AVEK	20	—	23	—	22	—	4.5	—	70	—	1.5	trace	.20	
4-33	05-16-97	3	LAC/LAC	—	—	—	—	—	—	—	—	< .5	—	—	< .10	—	
4-34	05-16-97	3	LAC/LAC	23	—	27	—	25	—	4.5	—	79	—	—	< .10	—	

Table 11

Table 11. Trihalomethane concentrations, trihalomethane formation potentials, and associated parameters for water samples collected during cycles 1 and 2 of the injection, storage, and recovery study at Lancaster, Antelope Valley, California, April 1995 through January 1998—Continued

Sample collection site (local well name)	Sampling date	Day of cycle phase	Collected by/ analyzed by	CHCl ₃ ($\mu\text{g/L}$)	CHCl ₃ FP ($\mu\text{g/L}$)	CHCl ₂ Br ($\mu\text{g/L}$)	CHCl ₂ Br FP ($\mu\text{g/L}$)	CHBr ₂ Cl ($\mu\text{g/L}$)	CHBr ₂ Cl FP ($\mu\text{g/L}$)	CHBr ₃ ($\mu\text{g/L}$)	CHBr ₃ FP ($\mu\text{g/L}$)	TTHM ($\mu\text{g/L}$)	TTHM FP ($\mu\text{g/L}$)	Total organic carbon (mg/L)	Free residual chlorine (mg/L)	Total residual chlorine (mg/L)	Ultra-violet absorbance (per cm)
Cycle 2 recovery—Continued																	
4-34	05-16-97	3	AVEK/AVEK	22	—	24	—	23	—	4.0	—	72	—	1.5	trace	0.20	0.028
4-42	05-16-97	3	LAC/LAC	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—	
4-13	05-17-97	4	LAC/LAC	—	—	—	—	—	—	—	.7	—	—	—	<.10	—	
4-32	05-17-97	4	LAC/LAC	22	—	24	—	21	—	5.1	—	72	—	—	—	<.10	—
4-33	05-17-97	4	LAC/LAC	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—	
4-34	05-17-97	4	LAC/LAC	23	—	23	—	22	—	4.3	—	71	—	—	—	<.10	—
4-42	05-17-97	4	LAC/LAC	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—	
4-13	05-18-97	5	LAC/LAC	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—	
4-33	05-18-97	5	LAC/LAC	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—	
4-42	05-18-97	5	LAC/LAC	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—	
4-13	05-19-97	6	LAC/LAC	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—	
4-32	05-19-97	6	LAC/LAC	21	—	19	—	15	—	4.6	—	59	—	—	—	<.10	—
4-33	05-19-97	6	LAC/LAC	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—	
4-34	05-19-97	6	LAC/LAC	16	—	21	—	17	—	4.0	—	58	—	—	—	<.10	—
4-42	05-19-97	6	LAC/LAC	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—	
4-13	05-20-97	7	LAC/LAC	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—	
4-32	05-20-97	7	LAC/LAC	18	—	26	—	18	—	5.3	—	68	—	—	—	<.10	—
4-33	05-20-97	7	LAC/LAC	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—	
4-34	05-20-97	7	LAC/LAC	16	—	24	—	18	—	4.5	—	62	—	—	—	<.10	—
4-42	05-20-97	7	LAC/LAC	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—	
4-13	05-21-97	8	LAC/LAC	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—	
4-32	05-21-97	8	LAC/LAC	21	—	29	—	21	—	5.1	—	75	—	—	—	<.10	—
4-33	05-21-97	8	LAC/LAC	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—	
4-34	05-21-97	8	LAC/LAC	19	—	28	—	18	—	4.6	—	70	—	—	—	<.10	—
4-42	05-21-97	8	LAC/LAC	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—	
4-13	05-22-97	9	LAC/LAC	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—	
4-32	05-22-97	9	LAC/LAC	19	—	22	—	20	—	5.2	—	67	—	—	—	<.10	—
4-32	05-22-97	9	AVEK/AVEK	19	—	20	—	19	—	3.1	—	61	—	1.5	ND	trace	.021
4-33	05-22-97	9	LAC/LAC	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—	
4-34	05-22-97	9	LAC/LAC	20	—	24	—	18	—	4.0	—	66	—	—	—	<.10	—

Table 11. Trihalomethane concentrations, trihalomethane formation potentials, and associated parameters for water samples collected during cycles 1 and 2 of the injection, storage, and recovery study at Lancaster, Antelope Valley, California, April 1995 through January 1998—Continued

Sample collection site (local well name)	Sampling date	Day of cycle phase	Collected by/ analyzed by	CHCl ₃ (µg/L)	CHCl ₃ FP (µg/L)	CHCl ₂ Br (µg/L)	CHCl ₂ Br FP (µg/L)	CHBr ₂ Cl (µg/L)	CHBr ₂ Cl FP (µg/L)	CHBr ₃ (µg/L)	CHBr ₃ FP (µg/L)	TTHM (µg/L)	TTHM FP (µg/L)	Total organic carbon (mg/L)	Free residual chlorine (mg/L)	Total residual chlorine (mg/L)	Ultra-violet absorbance (per cm)
Cycle 2 recovery—Continued																	
4-34	05-22-97	9	AVEK/AVEK	19	—	21	—	19	—	3.1	—	62	—	1.3	ND	trace	0.026
4-42	05-22-97	9	LAC/LAC	—	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—
4-13	05-23-97	10	LAC/LAC	—	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—
4-32	05-23-97	10	LAC/LAC	19	—	22	—	18	—	3.8	—	63	—	—	—	<.10	—
4-33	05-23-97	10	LAC/LAC	—	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—
4-34	05-23-97	10	LAC/LAC	21	—	24	—	17	—	4.1	—	65	—	—	—	<.10	—
4-42	05-23-97	10	LAC/LAC	—	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—
4-13	05-24-97	11	LAC/LAC	—	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—
4-32	05-24-97	11	LAC/LAC	24	—	24	—	20	—	6.0	—	73	—	—	—	<.10	—
4-33	05-24-97	11	LAC/LAC	—	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—
4-34	05-24-97	11	LAC/LAC	23	—	27	—	19	—	4.6	—	74	—	—	—	<.10	—
4-42	05-24-97	11	LAC/LAC	—	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—
4-13	05-25-97	12	LAC/LAC	—	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—
4-32	05-25-97	12	LAC/LAC	23	—	24	—	18	—	5.2	—	70	—	—	—	<.10	—
4-33	05-25-97	12	LAC/LAC	—	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—
4-34	05-25-97	12	LAC/LAC	23	—	25	—	18	—	3.9	—	69	—	—	—	<.10	—
4-42	05-25-97	12	LAC/LAC	—	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—
4-13	05-26-97	13	LAC/LAC	—	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—
4-32	05-26-97	13	LAC/LAC	20	—	26	—	16	—	3.4	—	65	—	—	—	<.10	—
4-32	05-26-97	13	AVEK/AVEK	16	—	17	—	18	—	4.6	—	55	—	.9	ND	trace	.013
4-33	05-26-97	13	LAC/LAC	—	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—
4-34	05-26-97	13	LAC/LAC	22	—	26	—	17	—	3.3	—	68	—	—	—	<.10	—
4-42	05-26-97	13	LAC/LAC	—	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—
4-13	05-27-97	14	LAC/LAC	—	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—
4-32	05-27-97	14	LAC/LAC	20	—	20	—	17	—	3.0	—	61	—	—	—	<.10	—
4-33	05-27-97	14	LAC/LAC	—	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—
4-34	05-27-97	14	LAC/LAC	20	—	20	—	17	—	3.8	—	61	—	—	—	<.10	—
4-42	05-27-97	14	LAC/LAC	—	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—
4-13	05-28-97	15	LAC/LAC	—	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—
4-32	05-28-97	15	LAC/LAC	22	—	24	—	16	—	3.7	—	65	—	—	—	<.10	—

Table 11. Trihalomethane concentrations, trihalomethane formation potentials, and associated parameters for water samples collected during cycles 1 and 2 of the injection, storage, and recovery study at Lancaster, Antelope Valley, California, April 1995 through January 1998—Continued

Sample collection site (local well name)	Sampling date	Day of cycle phase	Collected by/ analyzed by	CHCl ₃ (μg/L)	CHCl ₃ FP (μg/L)	CHCl ₂ Br (μg/L)	CHCl ₂ Br FP (μg/L)	CHBr ₂ Cl (μg/L)	CHBr ₂ Cl FP (μg/L)	CHBr ₃ (μg/L)	CHBr ₃ FP (μg/L)	TTHM (μg/L)	TTHM FP (μg/L)	Total organic carbon (mg/L)	Free residual chlorine (mg/L)	Total residual chlorine (mg/L)	Ultra-violet absorbance (per cm)
Cycle 2 recovery—Continued																	
4-33	05-28-97	15	LAC/LAC	—	—	—	—	—	—	—	<0.5	—	—	—	—	<0.10	—
4-34	05-28-97	15	LAC/LAC	23	—	23	—	15	—	4.3	—	65	—	—	—	<.10	—
4-42	05-28-97	15	LAC/LAC	—	—	—	—	—	—	—	<.5	—	—	—	—	<.10	—
4-13	05-29-97	16	LAC/LAC	—	—	—	—	—	—	—	<.5	—	—	—	—	<.10	—
4-32	05-29-97	16	LAC/LAC	16	—	17	—	10	—	2.5	—	46	—	—	—	<.10	—
4-32	05-29-97	16	AVEK/AVEK	19	—	17	—	14	—	2.4	—	53	—	1.1	ND	trace	0.021
4-33	05-29-97	16	LAC/LAC	—	—	—	—	—	—	—	<.5	—	—	—	—	<.10	—
4-34	05-29-97	16	LAC/LAC	16	—	18	—	11	—	2.6	—	47	—	—	—	<.10	—
4-34	05-29-97	16	AVEK/AVEK	20	—	17	—	13	—	2.4	—	52	—	1.6	ND	.20	.02
4-42	05-29-97	16	LAC/LAC	—	—	—	—	—	—	—	<.5	—	—	—	—	<.10	—
4-13	05-30-97	17	LAC/LAC	—	—	—	—	—	—	—	<.5	—	—	—	—	<.10	—
4-32	05-30-97	17	LAC/LAC	22	—	20	—	15	—	3.9	—	60	—	—	—	<.10	—
4-33	05-30-97	17	LAC/LAC	—	—	—	—	—	—	—	<.5	—	—	—	—	<.10	—
4-34	05-30-97	17	LAC/LAC	20	—	23	—	16	—	3.9	—	62	—	—	—	<.10	—
4-42	05-30-97	17	LAC/LAC	—	—	—	—	—	—	—	<.5	—	—	—	—	<.10	—
4-13	05-31-97	18	LAC/LAC	—	—	—	—	—	—	—	<.5	—	—	—	—	<.10	—
4-32	05-31-97	18	LAC/LAC	21	—	23	—	14	—	<.5	—	58	—	—	—	<.10	—
4-33	05-31-97	18	LAC/LAC	—	—	—	—	—	—	—	<.5	—	—	—	—	<.10	—
4-34	05-31-97	18	LAC/LAC	21	—	21	—	15	—	4.6	—	61	—	—	—	<.10	—
4-42	05-31-97	18	LAC/LAC	—	—	—	—	—	—	—	<.5	—	—	—	—	<.10	—
4-13	06-01-97	19	LAC/LAC	—	—	—	—	—	—	—	<.5	—	—	—	—	<.10	—
4-32	06-01-97	19	LAC/LAC	25	—	21	—	15	—	5.6	—	66	—	—	—	<.10	—
4-33	06-01-97	19	LAC/LAC	—	—	—	—	—	—	—	<.5	—	—	—	—	<.10	—
4-34	06-01-97	19	LAC/LAC	25	—	22	—	16	—	4.4	—	68	—	—	—	<.10	—
4-42	06-01-97	19	LAC/LAC	—	—	—	—	—	—	—	<.5	—	—	—	—	<.10	—
4-13	06-02-97	20	LAC/LAC	—	—	—	—	—	—	—	<.5	—	—	—	—	<.10	—
4-32	06-02-97	20	LAC/LAC	24	—	24	—	14	—	4.8	—	67	—	—	—	<.10	—
4-33	06-02-97	20	LAC/LAC	—	—	—	—	—	—	—	<.5	—	—	—	—	<.10	—
4-34	06-02-97	20	LAC/LAC	23	—	24	—	15	—	4.0	—	66	—	—	—	<.10	—
4-42	06-02-97	20	LAC/LAC	—	—	—	—	—	—	—	<.5	—	—	—	—	<.10	—

Table 11. Trihalomethane concentrations, trihalomethane formation potentials, and associated parameters for water samples collected during cycles 1 and 2 of the injection, storage, and recovery study at Lancaster, Antelope Valley, California, April 1995 through January 1998—Continued

Sample collection site (local well name)	Sampling date	Day of cycle phase	Collected by/ analyzed by	CHCl ₃ (µg/L)	CHCl ₃ FP (µg/L)	CHCl ₂ Br (µg/L)	CHCl ₂ Br FP (µg/L)	CHBr ₂ Cl (µg/L)	CHBr ₂ Cl FP (µg/L)	CHBr ₃ (µg/L)	CHBr ₃ FP (µg/L)	TTHM (µg/L)	TTHM FP (µg/L)	Total organic carbon (mg/L)	Free residual chlorine (mg/L)	Total residual chlorine (mg/L)	Ultra-violet absorbance (per cm)
Cycle 2 recovery—Continued																	
4-13	06-03-97	21	LAC/LAC	—	—	—	—	—	—	—	—	< 0.5	—	—	—	< 0.10	—
4-32	06-03-97	21	LAC/LAC	25	—	20	—	20	—	< 0.5	—	62	—	—	—	< .10	—
4-33	06-03-97	21	LAC/LAC	—	—	—	—	—	—	—	—	< .5	—	—	—	< .10	—
4-34	06-03-97	21	LAC/LAC	24	—	20	—	13	—	4.9	—	62	—	—	—	< .10	—
4-42	06-03-97	21	LAC/LAC	—	—	—	—	—	—	—	—	< .5	—	—	—	< .10	—
4-13	06-04-97	22	LAC/LAC	—	—	—	—	—	—	—	—	< .5	—	—	—	< .10	—
4-32	06-04-97	22	LAC/LAC	28	—	27	—	17	—	8.3	—	80	—	—	—	< .10	—
4-33	06-04-97	22	LAC/LAC	—	—	—	—	—	—	—	—	< .5	—	—	—	< .10	—
4-34	06-04-97	22	LAC/LAC	26	—	26	—	19	—	6.5	—	77	—	—	—	< .10	—
4-42	06-04-97	22	LAC/LAC	—	—	—	—	—	—	—	—	< .5	—	—	—	< .10	—
4-13	06-05-97	23	LAC/LAC	—	—	—	—	—	—	—	—	< .5	—	—	—	< .10	—
4-32	06-05-97	23	LAC/LAC	24	—	20	—	15	—	6.7	—	65	—	—	—	< .10	—
4-32	06-05-97	23	AVEK/AVEK	19	—	16	—	14	—	3.1	—	53	—	1.1	—	—	0.017
4-33	06-05-97	23	LAC/LAC	—	—	—	—	—	—	—	—	< .5	—	—	—	< .10	—
4-34	06-05-97	23	LAC/LAC	26	—	21	—	16	—	5.8	—	68	—	—	—	< .10	—
4-34	06-05-97	23	AVEK/AVEK	20	—	17	—	13	—	2.7	—	53	—	1.1	—	—	.025
4-42	06-05-97	23	LAC/LAC	—	—	—	—	—	—	—	—	< .5	—	—	—	< .10	—
4-13	06-06-97	24	LAC/LAC	—	—	—	—	—	—	—	—	< .5	—	—	—	< .10	—
4-32	06-06-97	24	LAC/LAC	28	—	22	—	15	—	< .5	—	65	—	—	—	< .10	—
4-33	06-06-97	24	LAC/LAC	—	—	—	—	—	—	—	—	< .5	—	—	—	< .10	—
4-34	06-06-97	24	LAC/LAC	22	—	20	—	18	—	< .5	—	61	—	—	—	< .10	—
4-42	06-06-97	24	LAC/LAC	—	—	—	—	—	—	—	—	< .5	—	—	—	< .10	—
4-13	06-07-97	25	LAC/LAC	—	—	—	—	—	—	—	—	< .5	—	—	—	< .10	—
4-32	06-07-97	25	LAC/LAC	25	—	25	—	18	—	< .5	—	67	—	—	—	< .10	—
4-33	06-07-97	25	LAC/LAC	—	—	—	—	—	—	—	—	< .5	—	—	—	< .10	—
4-34	06-07-97	25	LAC/LAC	24	—	22	—	19	—	< .5	—	65	—	—	—	< .10	—
4-42	06-07-97	25	LAC/LAC	—	—	—	—	—	—	—	—	< .5	—	—	—	< .10	—
4-13	06-08-97	26	LAC/LAC	—	—	—	—	—	—	—	—	< .5	—	—	—	< .10	—
4-32	06-08-97	26	LAC/LAC	28	—	20	—	16	—	5.8	—	69	—	—	—	< .10	—
4-33	06-08-97	26	LAC/LAC	—	—	—	—	—	—	—	—	< .5	—	—	—	< .10	—

Table 11. Trihalomethane concentrations, trihalomethane formation potentials, and associated parameters for water samples collected during cycles 1 and 2 of the injection, storage, and recovery study at Lancaster, Antelope Valley, California, April 1995 through January 1998—Continued

Sample collection site (local well name)	Sampling date	Day of cycle phase	Collected by/ analyzed by	CHCl ₃ ($\mu\text{g/L}$)	CHCl ₃ FP ($\mu\text{g/L}$)	CHCl ₂ Br ($\mu\text{g/L}$)	CHCl ₂ Br FP ($\mu\text{g/L}$)	CHBr ₂ Cl ($\mu\text{g/L}$)	CHBr ₂ Cl FP ($\mu\text{g/L}$)	CHBr ₃ ($\mu\text{g/L}$)	CHBr ₃ FP ($\mu\text{g/L}$)	TTHM ($\mu\text{g/L}$)	TTHM FP ($\mu\text{g/L}$)	Total organic carbon (mg/L)	Free residual chlorine (mg/L)	Total residual chlorine (mg/L)	Ultra-violet absorbance (per cm)
Cycle 2 recovery—Continued																	
4-34	06-08-97	26	LAC/LAC	25	—	23	—	16	—	6.6	—	70	—	—	—	<0.10	—
4-42	06-08-97	26	LAC/LAC	—	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—
4-13	06-09-97	27	LAC/LAC	—	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—
4-32	06-09-97	27	LAC/LAC	21	—	18	—	15	—	5.7	—	59	—	—	—	<.10	—
4-33	06-09-97	27	LAC/LAC	—	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—
4-34	06-09-97	27	LAC/LAC	20	—	19	—	19	—	4.7	—	63	—	—	—	<.10	—
4-42	06-09-97	27	LAC/LAC	—	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—
4-13	06-10-97	28	LAC/LAC	—	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—
4-32	06-10-97	28	LAC/LAC	26	—	22	—	13	—	3.3	—	64	—	—	—	<.10	—
4-33	06-10-97	28	LAC/LAC	—	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—
4-34	06-10-97	28	LAC/LAC	24	—	20	—	15	—	4.6	—	63	—	—	—	<.10	—
4-42	06-10-97	28	LAC/LAC	—	—	—	—	—	—	—	—	<.5	—	—	—	.11	—
4-13	06-11-97	29	LAC/LAC	—	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—
4-32	06-11-97	29	LAC/LAC	21	—	17	—	13	—	4.4	—	56	—	—	—	.13	—
4-33	06-11-97	29	LAC/LAC	—	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—
4-34	06-11-97	29	LAC/LAC	15	—	16	—	13	—	5.1	—	48	—	—	—	.11	—
4-42	06-11-97	29	LAC/LAC	—	—	—	—	—	—	—	—	<.5	—	—	—	.13	—
4-13	06-12-97	30	LAC/LAC	<.5	—	<.5	—	<.5	—	<.5	—	<.5	—	—	—	<.10	—
4-32	06-12-97	30	LAC/LAC	21	—	17	—	15	—	5.3	—	58	—	—	—	<.10	—
4-32	06-12-97	30	AVEK/AVEK	20	—	17	—	15	—	3.5	—	55	—	1.1	ND	ND	0.016
4-33	06-12-97	30	LAC/LAC	<.5	—	<.5	—	<.5	—	<.5	—	<.5	—	—	—	<.10	—
4-34	06-12-97	30	LAC/LAC	17	—	18	—	16	—	3.8	—	54	—	—	—	.11	—
4-34	06-12-97	30	AVEK/AVEK	18	—	17	—	16	—	3.9	—	56	—	1.0	ND	ND	.019
4-42	06-12-97	30	LAC/LAC	<.5	—	<.5	—	<.5	—	<.5	—	<.5	—	—	—	.17	—
4-13	06-13-97	31	LAC/LAC	—	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—
4-32	06-13-97	31	LAC/LAC	17	—	16	—	16	—	5.8	—	55	—	—	—	<.10	—
4-33	06-13-97	31	LAC/LAC	—	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—
4-34	06-13-97	31	LAC/LAC	17	—	17	—	18	—	5.9	—	59	—	—	—	<.10	—
4-42	06-13-97	31	LAC/LAC	—	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—
4-13	06-14-97	32	LAC/LAC	—	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—

Table 11. Trihalomethane concentrations, trihalomethane formation potentials, and associated parameters for water samples collected during cycles 1 and 2 of the injection, storage, and recovery study at Lancaster, Antelope Valley, California, April 1995 through January 1998—Continued

Sample collection site (local well name)	Sampling date	Day of cycle phase	Collected by/ analyzed by	CHCl ₃ (µg/L)	CHCl ₃ FP (µg/L)	CHCl ₂ Br (µg/L)	CHCl ₂ Br FP (µg/L)	CHBr ₂ Cl (µg/L)	CHBr ₂ Cl FP (µg/L)	CHBr ₃ (µg/L)	CHBr ₃ FP (µg/L)	TTHM (µg/L)	TTHM FP (µg/L)	Total organic carbon (mg/L)	Free residual chlorine (mg/L)	Total residual chlorine (mg/L)	Ultra-violet absorbance (per cm)
Cycle 2 recovery—Continued																	
4-32	06-14-97	32	LAC/LAC	20	—	19	—	18	—	6.9	—	65	—	—	—	< 0.10	—
4-33	06-14-97	32	LAC/LAC	—	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—
4-34	06-14-97	32	LAC/LAC	17	—	20	—	25	—	8.9	—	72	—	—	—	<.10	—
4-42	06-14-97	32	LAC/LAC	—	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—
4-13	06-15-97	33	LAC/LAC	—	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—
4-32	06-15-97	33	LAC/LAC	25	—	22	—	18	—	<.5	—	64	—	—	—	<.10	—
4-33	06-15-97	33	LAC/LAC	—	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—
4-34	06-15-97	33	LAC/LAC	19	—	23	—	21	—	<.5	—	63	—	—	—	<.10	—
4-42	06-15-97	33	LAC/LAC	—	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—
4-32	06-16-97	34	LAC/LAC	20	—	24	—	21	—	<.5	—	65	—	—	—	<.10	—
4-34	06-16-97	34	LAC/LAC	20	—	24	—	21	—	<.5	—	65	—	—	—	.12	—
4-32	06-19-97	37	AVEK/AVEK	18	—	18	—	17	—	4.1	—	57	—	1.3	ND	ND	.021
4-34	06-19-97	37	AVEK/AVEK	15	—	16	—	17	—	4.1	—	52	—	1.3	ND	ND	.020
4-32	06-24-97	42	LAC/LAC	13	—	22	—	16	—	5.8	—	57	—	—	—	<.10	—
4-34	06-24-97	42	LAC/LAC	15	—	25	—	18	—	7.8	—	66	—	—	—	<.10	—
4-32	06-26-97	44	AVEK/AVEK	16	—	17	—	18	—	4.6	—	55	—	.9	ND	trace	.013
4-34	06-26-97	44	AVEK/AVEK	13	—	16	—	17	—	4.6	—	50	—	.9	ND	trace	.017
4-32	07-01-97	49	LAC/LAC	14	—	18	—	19	—	6.4	—	57	—	—	—	<.10	—
4-34	07-01-97	49	LAC/LAC	12	—	16	—	18	—	4.9	—	50	—	—	—	<.10	—
4-32	07-03-97	51	AVEK/AVEK	14	—	17	—	17	—	5.0	—	53	—	.9	ND	trace	.016
4-34	07-03-97	51	AVEK/AVEK	12	—	15	—	17	—	5.4	—	50	—	.8	ND	trace	.017
4-13	07-08-97	56	LAC/LAC	—	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—
4-32	07-08-97	56	LAC/LAC	13	—	18	—	21	—	5.8	—	58	—	—	—	<.10	—
4-33	07-08-97	56	LAC/LAC	—	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—
4-34	07-08-97	56	LAC/LAC	13	—	16	—	23	—	5.5	—	57	—	—	—	<.10	—
4-42	07-08-97	56	LAC/LAC	—	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—
4-32	07-10-97	58	AVEK/AVEK	12	—	16	—	18	—	4.9	—	51	—	.9	ND	.10	.020
4-34	07-10-97	58	AVEK/AVEK	11	—	14	—	16	—	4.9	—	45	—	1.2	ND	.35	.012
4-32	07-15-97	63	LAC/LAC	16	—	14	—	18	—	5.9	—	54	—	—	—	<.10	—
4-34	07-15-97	63	LAC/LAC	12	—	22	—	16	—	4.3	—	54	—	—	—	<.10	—

Table 11. Trihalomethane concentrations, trihalomethane formation potentials, and associated parameters for water samples collected during cycles 1 and 2 of the injection, storage, and recovery study at Lancaster, Antelope Valley, California, April 1995 through January 1998—Continued

Sample collection site (local well name)	Sampling date	Day of cycle phase	Collected by/ analyzed by	CHCl ₃ ($\mu\text{g/L}$)	CHCl ₃ FP ($\mu\text{g/L}$)	CHCl ₂ Br ($\mu\text{g/L}$)	CHCl ₂ Br FP ($\mu\text{g/L}$)	CHBr ₂ Cl ($\mu\text{g/L}$)	CHBr ₂ Cl FP ($\mu\text{g/L}$)	CHBr ₃ ($\mu\text{g/L}$)	CHBr ₃ FP ($\mu\text{g/L}$)	TTHM ($\mu\text{g/L}$)	TTHM FP ($\mu\text{g/L}$)	Total organic carbon (mg/L)	Free residual chlorine (mg/L)	Total residual chlorine (mg/L)	Ultra-violet absorbance (per cm)
Cycle 2 recovery—Continued																	
4-32	07-17-97	65	AVEK/AVEK	11	—	14	—	17	—	4.7	—	46	—	0.8	trace	0.15	0.020
4-34	07-17-97	65	AVEK/AVEK	9.7	—	13	—	15	—	4.1	—	42	—	.7	trace	.10	.011
4-32	07-23-97	71	LAC/LAC	11	—	15	—	16	—	5.4	—	48	—	—	—	<.10	—
4-34	07-23-97	71	LAC/LAC	9.1	—	12	—	12	—	5.7	—	38	—	—	—	<.10	—
4-32	07-24-97	72	AVEK/AVEK	9.7	—	14	—	16	—	4.6	—	43	—	.7	ND	trace	.014
4-34	07-24-97	72	AVEK/AVEK	8.7	—	12	—	12	—	4.2	—	37	—	.7	ND	trace	.009
4-32	07-29-97	77	LAC/LAC	8.7	—	15	—	16	—	4.1	—	44	—	—	—	<.10	—
4-34	07-29-97	77	LAC/LAC	8.0	—	12	—	12	—	3.8	—	37	—	—	—	<.10	—
4-32	07-31-97	79	AVEK/AVEK	8.6	—	12	—	14	—	4.2	—	39	—	.7	ND	.20	.011
4-34	07-31-97	79	AVEK/AVEK	7.4	—	9.8	—	11	—	3.5	—	32	—	.5	ND	.20	.009
4-32	08-05-97	84	LAC/LAC	9.3	—	17	—	16	—	4.7	—	47	—	—	—	<.10	—
4-34	08-05-97	84	LAC/LAC	9.2	—	14	—	13	—	5.5	—	41	—	—	—	.10	—
4-32	08-07-97	86	AVEK/AVEK	8.1	—	11	—	12	—	3.8	—	35	—	.6	ND	.10	.009
4-34	08-07-97	86	AVEK/AVEK	7.3	—	9.2	—	11	—	3.0	—	30	—	.6	ND	.10	.009
4-13	08-12-97	91	LAC/LAC	—	—	—	—	—	—	—	—	4.2	—	—	—	<.10	—
4-32	08-12-97	91	LAC/LAC	8.9	—	21	—	13	—	4.1	—	38	—	—	—	<.10	—
4-34	08-12-97	91	LAC/LAC	7.9	—	9.9	—	12	—	3.4	—	33	—	—	—	<.10	—
4-42	08-12-97	91	LAC/LAC	—	—	—	—	—	—	—	<.5	—	—	—	—	<.10	—
4-32	08-14-97	93	AVEK/AVEK	6.9	—	9.8	—	11	—	3.3	—	31	—	.6	ND	.10	.009
4-34	08-14-97	93	AVEK/AVEK	6.1	—	7.8	—	9.4	—	2.8	—	26	—	.5	ND	.10	.011
4-32	08-19-97	98	LAC/LAC	6.5	—	10	—	8.7	—	<.5	—	26	—	—	—	<.10	—
4-34	08-19-97	98	LAC/LAC	6.3	—	8.4	—	9.8	—	<.5	—	25	—	—	—	<.10	—
4-32	08-21-97	100	AVEK/AVEK	6.0	—	8.3	—	9.1	—	2.9	—	26	—	.5	ND	.10	.006
4-34	08-21-97	100	AVEK/AVEK	5.0	—	6.7	—	7.6	—	2.4	—	22	—	<.5	ND	.10	.009
4-32	08-26-97	105	LAC/LAC	7.2	—	10	—	9.2	—	<.5	—	26	—	—	—	<.10	—
4-34	08-26-97	105	LAC/LAC	6.7	—	9.2	—	8.4	—	<.5	—	24	—	—	—	<.10	—
4-32	08-28-97	107	AVEK/AVEK	5.9	—	7.6	—	8.8	—	2.6	—	25	—	<.5	trace	.10	.006
4-34	08-28-97	107	AVEK/AVEK	5.2	—	6.5	—	7.8	—	2.3	—	22	—	.5	trace	.25	.009
4-32	09-02-97	112	LAC/LAC	6.3	—	7.6	—	9.4	—	<.5	—	23	—	—	—	<.10	—
4-34	09-02-97	112	LAC/LAC	4.8	—	7.0	—	6.6	—	<.5	—	18	—	—	—	<.10	—

Table 11. Trihalomethane concentrations, trihalomethane formation potentials, and associated parameters for water samples collected during cycles 1 and 2 of the injection, storage, and recovery study at Lancaster, Antelope Valley, California, April 1995 through January 1998—Continued

Sample collection site (local well name)	Sampling date	Day of cycle phase	Collected by/ analyzed by	CHCl ₃ (µg/L)	CHCl ₃ FP (µg/L)	CHCl ₂ Br (µg/L)	CHCl ₂ Br FP (µg/L)	CHBr ₂ Cl (µg/L)	CHBr ₂ Cl FP (µg/L)	CHBr ₃ (µg/L)	CHBr ₃ FP (µg/L)	TTHM (µg/L)	TTHM FP (µg/L)	Total organic carbon (mg/L)	Free residual chlorine (mg/L)	Total residual chlorine (mg/L)	Ultra-violet absorbance (per cm)
Cycle 2 recovery—Continued																	
4-32	09-04-97	114	AVEK/AVEK	5.0	—	6.4	—	7.5	—	3.4	—	21	—	< 0.5	ND	0.20	0.010
4-34	09-04-97	114	AVEK/AVEK	4.2	—	5.4	—	6.4	—	2.1	—	18	—	<.5	0.10	.20	.009
4-13	09-09-97	119	LAC/LAC	—	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—
4-32	09-09-97	119	LAC/LAC	5.1	—	7.9	—	7.3	—	<.5	—	20	—	—	—	<.10	—
4-34	09-09-97	119	LAC/LAC	4.0	—	6.7	—	5.9	—	<.5	—	17	—	—	—	<.10	—
4-42	09-09-97	119	LAC/LAC	—	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—
4-32	09-11-97	121	AVEK/AVEK	4.4	—	5.6	—	6.7	—	2.2	—	19	—	<.5	ND	trace	.008
4-34	09-11-97	121	AVEK/AVEK	4.0	—	5.1	—	5.7	—	1.9	—	17	—	.6	ND	trace	.009
4-32	09-16-97	126	LAC/LAC	5.0	—	6.9	—	5.9	—	<.5	—	18	—	—	—	<.10	—
4-33	09-16-97	126	LAC/LAC	—	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—
4-34	09-16-97	126	LAC/LAC	4.7	—	6.1	—	5.6	—	<.5	—	16	—	—	—	<.10	—
4-32	09-18-97	128	AVEK/AVEK	4.0	—	5.3	—	6.0	—	2.0	—	17	—	<.5	.15	.20	.007
4-34	09-18-97	128	AVEK/AVEK	3.5	—	4.4	—	5.0	—	1.7	—	15	—	<.5	trace	.15	.005
4-32	09-24-97	134	LAC/LAC	3.6	—	4.7	—	5.7	—	<.5	—	14	—	—	—	<.10	—
4-34	09-24-97	134	LAC/LAC	3.3	—	4.2	—	5.5	—	<.5	—	13	—	—	—	<.10	—
4-32	09-25-97	135	AVEK/AVEK	3.7	—	4.6	—	5.0	—	1.9	—	15	—	<.5	ND	trace	.006
4-34	09-25-97	135	AVEK/AVEK	3.2	—	4.1	—	4.6	—	2.0	—	14	—	<.5	trace	—	.004
4-32	10-01-97	141	LAC/LAC	3.7	—	4.0	—	4.3	—	<.5	—	12	—	—	—	<.10	—
4-34	10-01-97	141	LAC/LAC	3.0	—	3.9	—	4.3	—	<.5	—	11	—	—	—	<.10	—
4-32	10-02-97	142	AVEK/AVEK	3.3	—	4.3	—	4.7	—	2.1	—	14	—	.5	ND	trace	.006
4-34	10-02-97	142	AVEK/AVEK	3.1	—	3.9	—	4.3	—	2.0	—	13	—	.6	ND	trace	.005
4-32	10-08-97	148	LAC/LAC	2.2	—	3.4	—	5.0	—	<.5	—	11	—	—	—	<.10	—
4-34	10-08-97	148	LAC/LAC	2.0	—	4.3	—	4.1	—	<.5	—	10	—	—	—	<.10	—
4-32	10-09-97	149	AVEK/AVEK	3.0	—	3.7	—	4.1	—	2.0	—	13	—	<.5	trace	.10	.009
4-34	10-09-97	149	AVEK/AVEK	2.7	—	3.5	—	3.7	—	1.8	—	12	—	<.5	trace	.10	.005
4-13	10-14-97	154	LAC/LAC	—	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—
4-32	10-14-97	154	LAC/LAC	5.3	—	6.9	—	5.7	—	1.5	—	19	—	—	—	<.10	—
4-33	10-14-97	154	LAC/LAC	—	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—
4-34	10-14-97	154	LAC/LAC	4.0	—	5.1	—	4.8	—	1.0	—	15	—	—	—	<.10	—
4-42	10-14-97	154	LAC/LAC	—	—	—	—	—	—	—	—	<.5	—	—	—	<.10	—

Table 11. Trihalomethane concentrations, trihalomethane formation potentials, and associated parameters for water samples collected during cycles 1 and 2 of the injection, storage, and recovery study at Lancaster, Antelope Valley, California, April 1995 through January 1998—Continued

Sample collection site (local well name)	Sampling date	Day of cycle phase	Collected by/ analyzed by	CHCl ₃ (μg/L)	CHCl ₃ FP (μg/L)	CHCl ₂ Br (μg/L)	CHCl ₂ Br FP (μg/L)	CHBr ₂ Cl (μg/L)	CHBr ₂ Cl FP (μg/L)	CHBr ₃ (μg/L)	CHBr ₃ FP (μg/L)	TTHM (μg/L)	TTHM FP (μg/L)	Total organic carbon (mg/L)	Free residual chlorine (mg/L)	Total residual chlorine (mg/L)	Ultra-violet absorbance (per cm)
Cycle 2 recovery—Continued																	
4-32	10-16-97	156	AVEK/AVEK	2.8	—	3.3	—	3.6	—	1.9	—	12	—	< 0.5	trace	trace	0.006
4-34	10-16-97	156	AVEK/AVEK	2.6	—	3.3	—	3.5	—	1.9	—	11	—	< .5	trace	trace	.004
4-32	10-21-97	161	LAC/LAC	3.6	—	4.2	—	3.8	—	1.4	—	13	—	—	—	< 0.10	—
4-34	10-21-97	161	LAC/LAC	4.8	—	7.1	—	5.4	—	1.7	—	19	—	—	—	< .10	—
4-32	10-23-97	163	AVEK/AVEK	2.4	—	3.0	—	3.1	—	1.7	—	10	—	< .5	ND	trace	.003
4-34	10-23-97	163	AVEK/AVEK	2.3	—	2.9	—	3.0	—	1.7	—	9.9	—	< .5	ND	trace	.005
4-32	10-29-97	169	LAC/LAC	3.6	—	2.4	—	2.3	—	.5	—	8.8	—	—	—	< .10	—
4-34	10-29-97	169	LAC/LAC	3.2	—	2.0	—	2.0	—	< .5	—	7.2	—	—	—	< .10	—
4-32	10-30-97	170	AVEK/AVEK	2.1	—	2.5	—	2.7	—	1.6	—	8.9	—	.6	trace	.20	.011
4-34	10-30-97	170	AVEK/AVEK	2.0	—	2.6	—	2.9	—	1.7	—	9.2	—	< .5	ND	.10	.007
4-32	11-05-97	176	LAC/LAC	—	—	—	—	—	—	—	—	10	—	—	—	< .10	—
4-34	11-05-97	176	LAC/LAC	—	—	—	—	—	—	—	—	9.6	—	—	—	< .10	—
4-32	11-06-97	177	AVEK/AVEK	2.0	—	2.4	—	2.4	—	1.6	—	8.3	—	—	trace	.10	.008
4-34	11-06-97	177	AVEK/AVEK	1.9	—	2.3	—	2.6	—	1.6	—	8.3	—	—	trace	.10	.003
4-13	11-12-97	183	LAC/LAC	—	—	—	—	—	—	—	—	< .5	—	—	—	< .10	—
4-32	11-12-97	183	LAC/LAC	—	—	—	—	—	—	—	—	7.5	—	—	—	< .10	—
4-33	11-12-97	183	LAC/LAC	—	—	—	—	—	—	—	—	< .5	—	—	—	< .10	—
4-34	11-12-97	183	LAC/LAC	—	—	—	—	—	—	—	—	7.1	—	—	—	< .10	—
4-42	11-12-97	183	LAC/LAC	—	—	—	—	—	—	—	—	< .5	—	—	—	< .10	—
4-32	11-13-97	184	AVEK/AVEK	1.9	—	2.3	—	2.3	—	1.3	—	7.8	—	—	ND	ND	.002
4-34	11-13-97	184	AVEK/AVEK	2.0	—	2.3	—	2.6	—	1.3	—	8.2	—	—	ND	ND	.000
4-32	11-19-97	190	LAC/LAC	—	—	—	—	—	—	—	—	7.1	—	—	—	< .10	—
4-34	11-19-97	190	LAC/LAC	—	—	—	—	—	—	—	—	7.9	—	—	—	< .10	—
4-32	11-20-97	191	AVEK/AVEK	1.9	—	2.3	—	2.4	—	1.3	—	8.0	—	—	ND	ND	.001
4-34	11-20-97	191	AVEK/AVEK	1.9	—	2.2	—	2.5	—	1.3	—	7.8	—	—	ND	ND	.002
4-32	11-26-97	197	LAC/LAC	—	—	—	—	—	—	—	—	7.2	—	—	—	< .10	—
4-34	11-26-97	197	LAC/LAC	—	—	—	—	—	—	—	—	8.8	—	—	—	< .10	—
4-32	11-26-97	197	AVEK/AVEK	1.7	—	2.0	—	2.1	—	1.3	—	7.1	—	< .5	ND	trace	.001
4-34	11-26-97	197	AVEK/AVEK	1.6	—	2.1	—	2.3	—	1.3	—	7.3	—	< .5	ND	trace	.000
4-32	12-03-97	204	LAC/LAC	—	—	—	—	—	—	—	—	8.4	—	—	—	< .10	—

Table 11. Trihalomethane concentrations, trihalomethane formation potentials, and associated parameters for water samples collected during cycles 1 and 2 of the injection, storage, and recovery study at Lancaster, Antelope Valley, California, April 1995 through January 1998—Continued

Sample collection site (local well name)	Sampling date	Day of cycle phase	Collected by/ analyzed by	CHCl ₃ (µg/L)	CHCl ₃ FP (µg/L)	CHCl ₂ Br (µg/L)	CHCl ₂ Br FP (µg/L)	CHBr ₂ Cl (µg/L)	CHBr ₂ Cl FP (µg/L)	CHBr ₃ (µg/L)	CHBr ₃ FP (µg/L)	TTHM (µg/L)	TTHM FP (µg/L)	Total organic carbon (mg/L)	Free residual chlorine (mg/L)	Total residual chlorine (mg/L)	Ultra-violet absorbance (per cm)
Cycle 2 recovery—Continued																	
4-34	12-03-97	204	LAC/LAC	—	—	—	—	—	—	—	—	7.2	—	—	—	< 0.10	—
4-32	12-04-97	205	AVEK/AVEK	1.5	—	1.8	—	1.9	—	1.3	—	6.6	—	< 0.5	ND	ND	0.002
4-34	12-04-97	205	AVEK/AVEK	1.6	—	2.0	—	2.3	—	1.3	—	7.2	—	< .5	ND	ND	.003
4-13	12-10-97	211	LAC/LAC	—	—	—	—	—	—	—	—	< .5	—	—	—	< .10	—
4-32	12-10-97	211	LAC/LAC	—	—	—	—	—	—	—	—	5.2	—	—	—	< .10	—
4-34	12-10-97	211	LAC/LAC	—	—	—	—	—	—	—	—	7.9	—	—	—	< .10	—
4-42	12-10-97	211	LAC/LAC	—	—	—	—	—	—	—	—	.8	—	—	—	< .10	—
4-32	12-11-97	212	AVEK/AVEK	1.6	—	1.9	—	2.0	—	<.5	—	5.5	—	< .5	ND	trace	.001
4-34	12-11-97	212	AVEK/AVEK	1.7	—	2.1	—	2.4	—	<.5	—	6.2	—	< .5	ND	ND	.000
4-32	12-18-97	219	LAC/LAC	—	—	—	—	—	—	—	—	4.5	—	—	—	< .10	—
4-34	12-18-97	219	LAC/LAC	—	—	—	—	—	—	—	—	6.0	—	—	—	< .10	—
4-32	12-18-97	219	AVEK/AVEK	1.5	—	1.8	—	1.8	—	<.5	—	5.0	—	—	ND	ND	.008
4-34	12-18-97	219	AVEK/AVEK	1.7	—	2.1	—	2.3	—	<.5	—	6.2	—	—	ND	ND	.004
4-32	12-24-97	225	LAC/LAC	—	—	—	—	—	—	—	—	5.6	—	—	—	< .10	—
4-34	12-24-97	225	LAC/LAC	—	—	—	—	—	—	—	—	6.9	—	—	—	< .10	—
4-32	12-24-97	225	AVEK/AVEK	1.4	—	1.7	—	1.7	—	<.5	—	4.8	—	—	ND	ND	.006
4-34	12-24-97	225	AVEK/AVEK	1.6	—	2.0	—	2.2	—	<.5	—	5.8	—	—	ND	ND	.004
4-32	12-31-97	232	LAC/LAC	—	—	—	—	—	—	—	—	5.9	—	—	—	< .10	—
4-34	12-31-97	232	LAC/LAC	—	—	—	—	—	—	—	—	6.4	—	—	—	< .10	—
4-32	12-31-97	232	AVEK/AVEK	1.4	—	1.6	—	1.7	—	<.5	—	4.7	—	—	ND	ND	.011
4-34	12-31-97	232	AVEK/AVEK	1.5	—	2.0	—	2.2	—	<.5	—	5.6	—	—	ND	ND	.005
4-32	01-05-98	237	LAC/LAC	—	—	—	—	—	—	—	—	5.4	—	—	—	< .10	—
4-34	01-05-98	237	LAC/LAC	—	—	—	—	—	—	—	—	7.2	—	—	—	< .10	—
4-13	01-12-98	244	LAC/LAC	—	—	—	—	—	—	—	—	< .5	—	—	—	< .10	—
4-32	01-12-98	244	LAC/LAC	1.2	—	1.7	—	1.7	—	<.5	—	4.6	—	—	—	< .10	—
4-34	01-12-98	244	LAC/LAC	1.6	—	2.2	—	2.0	—	<.5	—	5.8	—	—	—	< .10	—
4-42	01-12-98	244	LAC/LAC	—	—	—	—	—	—	—	—	< .5	—	—	—	< .10	—